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The Engineer

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PUBLIC NOTICES

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 7th February, 1930, for EXTENSIONS to the HEATING and HOT WATER MAINS at Somerset House, W.C.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 4256

Civil Service Commission.

FORTHCOMING EXAMINATION.

ASSISTANT EXAMINERS in the Patent Office (20-25, with extension in certain cases).

Regulations and particulars, together with the forms on which applications must be made, will be sent in response to requests (preferably by postcard), addressed to the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1. The latest date for the receipt of application forms is 6th March, 1930. 3846

Crown Agents for the Colonies.

COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/1968.—JUNIOR QUANTITY SURVEYOR REQUIRED by the ENGINEERING DEPARTMENT of the Kenya and Uganda Railway and Harbours for a tour of 20 to 30 months' service and possible extension. Salary £480, rising to £600 a year by annual increments of £20. Free quarters and passages and liberal leave on full salary. Candidates, 23 to 28 years of age, should have passed the intermediate examination of the Surveyors' Institution in the Quantities Sub-division and should have served articles with a Quantity Surveyor of repute. They should be capable of working up Bills of Quantities without supervision, and of taking off Quantities for simple Structures and writing Specifications therefor. They should be generally conversant with the routine of a Quantity Surveyor's Office.

Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/1968. 4289

In the Matter of LETTERS PATENT granted to BERNARD HARTLEY PETER bearing date the 28th April, 1914, and numbered 10,532/1914 for the invention of "Improvements in and relating to Alternating-current Track Signalling."

Notice is Hereby Given that on the 25th February 1930 an Originating Summons (1929, P. No. 2124) issued out of the High Court of Justice, Chancery Division, on behalf of BERNARD HARTLEY PETER and the WESTINGHOUSE BRAKE and SAXBY SIGNAL COMPANY LIMITED, asking that the term of the Patent may be extended for a further term of five years will come before Mr. Justice Luxmoore for directions as to the hearing and any person desirous of being heard in opposition must at least 7 days before that date lodge Notice of Opposition (giving an address for service within the United Kingdom) at Room 175 Royal Courts of Justice, Strand, London, and serve a copy thereof upon the undermentioned Solicitor and upon the Solicitor to the Board of Trade.

Dated this 20th day of January, 1930.

GEORGE BELOE ELLIS,
70 and 72, Chancery-lane, London, W.C. 2,
Upon whom all documents requiring service may be served. 4229

In the High Court of Justice 1930 J. 91.
Chancery Division
Mr. Justice Bennett.
In the Matter of J. G. WHITE and COMPANY, LIMITED, and
In the Matter of the COMPANIES ACT, 1929.

Notice is Hereby Given that a Petition was on the third January one thousand nine hundred and thirty presented to the High Court of Justice by the above-named Company to confirm an alteration of the provisions of the Memorandum of Association with respect to the said Company's objects proposed to be effected by a special resolution of the said Company duly passed at an extraordinary general meeting held on the twelfth December one thousand nine hundred and twenty-nine whereby it was resolved that the objects of the Company be extended so as to enable the Company to carry on its business more efficiently and to enlarge the area of its operations and in particular to enable it to carry on business as (i) Financiers, Underwriters etc. (ii) To deal in negotiable or transferable securities (iii) To transact trust and agency business (iv) To acquire or otherwise deal in all kinds of property and rights (v) To deal in stocks and shares of all kinds and enter into agreements of all kinds with other Companies and undertakings—with the usual ancillary powers for the purpose.

A print of the Memorandum of Association submitted to the said Meeting containing the new subclauses will be sent on request to any person interested in the assets of the said Company and such print of the Memorandum of Association may be inspected at the offices of the Company situate at 9 Cloak-lane, Cannon-street, London, E.C. 4, also at the office of the undersigned the Solicitors of the Company.

And Notice is further given that the said Petition is directed to be heard before Mr. Justice Bennett at the Royal Courts of Justice, Strand, London, on Tuesday the 11th day of February one thousand nine hundred and thirty and any person interested in the assets of the said Company desirous of opposing the making of an Order for the confirmation of the said alteration under the above Act may appear at the time of hearing by himself or his Counsel for the purpose and he is required to give two clear days' previous notice in writing of his intention so to appear with the grounds of his objection to the undersigned the Solicitors of the said Company.

A copy of the said Petition will be furnished to any such person requiring the same by the undersigned on payment of the regulated charge for the same.

Dated the Twenty second day of January One thousand nine hundred and thirty.

A. KEEN,
Master.

BIRKBECK JULIUS EDWARDS & CO.,
49, Moorgate, London, E.C. 2,
Solicitors for the above-named Company. 4276

PUBLIC NOTICES

Administrative County of London.

SCAVENGING, &c., OF THAMES EMBANKMENTS AND BRIDGES.

The London County Council invites TENDERS for the SCAVENGING, &c., of, and the SUPPLY and DELIVERY of GRANITE, CHIPPINGS, SHINGLE, and SAND to the Thames Embankments and Bridges for a period of twelve months, commencing 1st April, 1930.

The form of Tender, &c., may be obtained on application to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1, upon payment of £1 by cheque, draft or money order, to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before payment of fee.

Remittances by post to be addressed to the Chief Engineer, the Old County Hall, Spring-gardens, S.W. 1. Personal inquiries at Room 3A, No. 3 Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 10th February, 1930, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
4266 Clerk of the London County Council.

City of Leicester—Water Department.

SECOND DERWENT PIPE LINE.

The Water Committee are prepared to receive TENDERS for the LAYING of 12 MILES of 36in. diameter WATER MAIN.

The specification, bill of quantities and form of Tender may be obtained by appliaction to the undersigned, and the drawings and all documents in connection with the contract may be inspected at the Waterworks Offices, Bowling Green-street, Leicester.

Tenders, duly signed and enclosed in a sealed envelope endorsed "Second Derwent Pipe Line, Contract No. 2," and addressed to the Chairman of the Water Committee, Bowling Green-street, Leicester, must be received by 10 a.m. on the 14th day of February, 1930.

The Corporation do not bind themselves to accept the lowest or any Tender.

G. T. EDWARDS, M. Inst. C.E.,
4240 Engineer and Manager.

PUBLIC NOTICES

Bombay, Baroda and Central India Railway Company.

The Directors are prepared to receive up to Noon on Friday, 7th February, TENDERS for the SUPPLY of :—

1. PIG IRON (GARTSHERRIE NO. 3 and WEST COAST HEMATITE) ;
2. COPPER RODS and TUBING ;

and up to Noon on Friday, 21st February, TENDERS for the SUPPLY of :—

3. STEEL MATERIAL (ANGLES, FLATS, PLATES, SHEETS, &c.).

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each for Nos. 1 and 2, and 20s. each for No. 3 (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
22nd January, 1930. 4277

Barking Town Urban District Council.

ILFORD AND BARKING JOINT SEWERAGE.

SEWERS.

CONTRACT NO. 4.

The Council of the Urban District of Barking Town are prepared to receive TENDERS for the CONSTRUCTION of about 3320 YARDS of CONCRETE TUBE SEWERS, varying in size from 15in. to 33in. diameter, and about 1420 YARDS of 9in. and 12in. STONEWARE PIPE SEWERS, together with MANHOLES and other APPURTENANT WORKS.

Plans may be seen and general conditions of contract, specification, quantities and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.

Plans may also be seen at the Council Offices, Barking.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders, to be delivered to the undersigned on or before the first post on Monday, February 17th, 1930, endorsed "Barking Sewers."

By Order,
S. A. JEWERS,
Clerk to the Council.

Council Offices, Barking,
22nd January, 1930. 4275

PUBLIC NOTICES

Barking Town Urban District Council.

EAST-STREET, LONGBRIDGE-ROAD AND FANSHAWE-AVENUE RECONSTRUCTION.

TO TRAMWAY AND PUBLIC WORKS CONTRACTORS.

The above Council invite TENDERS for the DISMANTLING of the existing LIGHT RAILWAY TRACK, the RECONSTRUCTION thereof, including the LAYING of about 230 TONS of RAIL, and the RESURFACING of CARRIAGEWAY with Granite Setts and Wood Blocks on New Concrete Foundation in East-street, Longbridge-road, and Fanshawe-avenue.

Conditions of contract, specification and form of Tender may be obtained and drawings inspected upon application to Mr. R. A. Lay, Assoc. M. Inst. C.E., Engineer and Surveyor to the Council, at the Public Offices, East-street, Barking.

The contractor whose Tender is accepted will be required to enter into a contract under seal with sufficient security for the due performance thereof.

Tenders should be delivered or forwarded in the special envelope provided for the purpose so as to reach the undersigned not later than 7 p.m. on the 28th instant.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
S. A. JEWERS,
Clerk to the Council.

Public Offices, Barking,
9th January, 1930. 4179

Borough of Ilford and Barking Town U.D.C.

ILFORD AND BARKING JOINT SEWERAGE COMMITTEE.

JOINT MAIN OUTFALL SEWER.

CONTRACT NO. 2.

The above Authorities are prepared to receive TENDERS for the CONSTRUCTION of about 1375 YARDS LIN. of CONCRETE in situ CULVERTS, varying in size from 65in. to 74in. diameter, together with MANHOLES and other APPURTENANT WORKS.

Plans may be seen and general conditions of contract, specification, quantities and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.

Plans may also be seen at the Council Offices, Barking, or the Town Hall, Ilford.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Monday, February 17th, 1930, endorsed "Joint Sewers."

By Order of the Joint Committee of the above Authorities,
ADAM PARTINGTON.

Town Hall, Ilford,
22nd January, 1930. 4273

Borough of Ilford.

ILFORD AND BARKING JOINT SEWERAGE.

SEWERS.

CONTRACT NO. 3.

The Corporation of Ilford is prepared to receive TENDERS for the CONSTRUCTION of about 3330 YARDS of CONCRETE in situ CULVERTS, varying in size from 58in. to 99in. diameter, and also for the CONSTRUCTION of various SHORT LENGTHS of CONCRETE TUBE SEWERS, varying in size from 21in. to 33in. diameter, together with MANHOLES and other APPURTENANT WORKS.

Plans may be seen and general conditions of contract, specification, quantities and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.

Plans may also be seen at the Town Hall, Ilford.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Monday, February 17th, 1930, endorsed "Ilford Sewers."

By Order,
ADAM PARTINGTON,
Town Clerk.

Town Hall, Ilford,
22nd January, 1930. 4274

Egyptian Delta Light Railways, Ltd.

2FT. 5½IN. GAUGE.

TENDERS are INVITED for the SUPPLY of :—

(1) AXLES for WAGONS.
(2) TYRES for WAGONS.
(3) WHEEL CENTRES for WAGONS.
(4) LAMINATED SPRINGS.
(5) AXLE-BOXES for WAGONS.

Forms of Tenders, schedules and specifications, with general conditions of contract, may be obtained at the offices of the EGYPTIAN DELTA LIGHT RAILWAYS, 210/216, Gresham House, Old Broad-street, E.C. 2, on payment of the sum of 10s. for each specification, which will not be returned.

Tenders, enclosed in sealed envelopes addressed to the "Chairman and Directors," must be delivered at the above address not later than Noon on Thursday, 6th February, 1930. 4254

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PUBLIC NOTICES

City of Liverpool.

OTTERSPOOL IMPROVEMENT SCHEME.
CONSTRUCTION OF RIVER WALL.
CONTRACT NO. 1.

The Corporation are prepared to receive TENDERS for the COMPLETION of the above-mentioned WORKS, in accordance with plans and specification prepared by the City Engineer.

The plans may be inspected and specification, bills of quantities and form of Tender obtained upon application at the City Engineer's Dept., Municipal Buildings, Dale-street, Liverpool, between the hours of 9 a.m. and 5 p.m., on payment of a deposit of £3 3s. to the City Treasurer, which amount will be refunded provided a bona fide Tender is submitted and not subsequently withdrawn.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders must be enclosed in the official envelopes provided, sealed and endorsed "Tender for River Wall, Otterspool Improvement Scheme," and forwarded through the post, addressed to :—

The Town Clerk,
Municipal Buildings, Liverpool.

Latest time and date for receipt of Tenders Ten o'clock a.m. on Monday, 24th February, 1930.

WALTER MOON,
Town Clerk.

22nd January, 1930. 4282

Great Western Railway.

The Directors of this Company are prepared to receive TENDERS for WIDENING the RAILWAY between Cogload Junction and Norton Fitzwarren—Contract No. 1—from Cogload Junction to Obridge Farm, about 4¼ miles in length.

Plans and specification may be seen and forms of Tender and bills of quantities obtained at the office of the Engineer at Paddington Station, between the hours of 10 a.m. and 4 p.m. on payment of £2 2s., which will be returned to bona fide tenderers.

Tenders, addressed to the undersigned and marked outside "Tender for Norton Fitzwarren Widening, Contract No. 1," will be received not later than 10 a.m. on Monday, the 10th February, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. DAVIS, Secy.

Paddington Station, London, 18th January, 1930. 4247

Metropolitan Water Board.

TENDERS FOR THE SUPPLY OF PHOTO PRINTS, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of PHOTO PRINTS, &c., for the periods of 6 and 12 months, commencing 1st April, 1930.

Tenders must be submitted on the official form (Contract No. 27), which may be obtained from the Chief Engineer on and after Monday, 20th January, 1930, by personal application at the Offices of the Board (Room 156), or upon forwarding a stamped addressed sack envelope. Samples of the paper required can be seen at the Offices of the Board (Room 201).

Tenders, enclosed in sealed envelopes addressed to The Clerk of the Board and endorsed "Tender for Photo Prints, &c.," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 17th February, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
14th January, 1930. 4251

Metropolitan Water Board.

TENDERS FOR PIPELAYING, &c.

The Metropolitan Water Board invite TENDERS for PIPE-LAYING, ALTERATIONS and BRICKLAYERS' WORK within the areas of their Kent, Northern, Southern and Western Districts, commencing 1st April, 1930.

Tenders must be submitted on the official forms (Contract No. 17), which may be obtained from the Chief Engineer on and after Monday, 20th January, 1930, by personal application at the Offices of the Board (Room 156), or upon forwarding a stamped, addressed sack envelope.

Tenders, enclosed in sealed envelopes, addressed to The Clerk of the Board and endorsed "Tender for Pipe-laying, &c.," must be delivered at the Offices of the Board (Room 122) not later than 11 a.m. on Monday, 17th February, 1930.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
14th January, 1930. 4252

Pembrokeshire County Council.

NEYLAND LANDING STAGE.

The Pembrokeshire County Council invite TENDERS for the above WORK, comprising the Construction of a Floating Landing Stage, a Bridge leading thereto, and Alterations to an existing Timber Jetty, in accordance with the plans and specification prepared by Messrs. Wilton and Bell, Chartered Civil Engineers.

The plans, specification, and forms of contract and of Tender may be seen either at the offices of the Engineers, 57/59, Victoria-street, Westminster, S.W. 1, or at the County Offices, Haverfordwest.

Contractors will be supplied with the specification and forms of contract and of Tender, and copies of the plans may be obtained on payment to the County Council of the sum of £2 (Two Pounds), which will not be returned.

Tenders must be sent in a sealed envelope to the Clerk of the County Council, marked "Tender for Neyland Landing Stage," and must reach his office at Haverfordwest before Twelve Noon on Saturday, February 15th, 1930.

The Council does not bind itself to accept the lowest or any Tender.

ROBERT A. WHEATLEY,
Clerk of the Pembrokeshire County Council.

County Offices, Haverfordwest,
14th January, 1930. 4199

South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

MADRAS IMPROVEMENTS—ELECTRIFICATION.
1. ELECTRIC OVERHEAD TRAVELLING CRANE—CAR SHED.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked : "Tender for Electric Overhead Travelling Crane," with the name of the firm tendering, must be left with the undersigned not later than 12 Noon on Friday, the 7th February, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of the Specification.

Copies of the Drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France,
Westminster, S.W. 1.
22nd January, 1930. 4291

PUBLIC NOTICES

The Madras and Southern Mahratta Railway Company, Limited,

invite TENDERS for :—

22 PAIRS WHEELS AND AXLES FOR CARRIAGES AND WAGONS (Metre Gauge).

Tenders are due in on Tuesday, 11th February, 1930, by 2 p.m.

Tender forms obtainable at address below : fee Half a Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1. 4241

Administrative County of London.

The London County Council has a VACANCY for a HANDICRAFT MASTER with qualifications in Metalwork, at Sirdar-road School (Kensington, N.). Candidates should be fully qualified Handicraft Masters, but applications will be considered from suitable candidates with some teaching experience who have passed the First Examination for Teachers of Handicraft (Metalwork) conducted by the City and Guilds of London Institute.

Salary—Burnham Scale IV. for certificated teachers in the case of fully qualified handicraft masters, and in other cases £180 fixed, pending completion of qualifications. Preference will be given to persons who served, or attempted to serve, with H.M. Forces.

Apply, Education Officer (E. 2), the County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary) for form, to be returned by 7th February. Canvassing disqualifies.

MONTAGU H. COX,
Clerk of the London County Council.
4238

City of Sheffield Water Department.

BURBAGE RESERVOIR AND WORKS.
RESIDENT CONSTRUCTING ENGINEER.

APPLICATIONS are INVITED for the APPOINTMENT of a qualified RESIDENT ENGINEER in connection with the Construction by direct labour of a Large Storage Reservoir on the Burbage and Houndkirk Moors, situate seven miles from Sheffield, at a salary of £1000 per annum.

The Engineer will be responsible for the preparation of all plans and designs, and for the construction of the reservoir and works connected therewith. He must be a qualified engineer and have had considerable practical experience in the design and construction of storage reservoirs, preferably formed by earthwork embankments.

The person appointed will be required to enter upon the duties at once, reside in the immediate vicinity of the works, and devote the whole of his time to the performance of his duties under the Corporation.

Applications, stating age, qualifications and experience, accompanied by copies of three recent testimonials, and endorsed "Burbage Engineer," to be sent to me not later than Tuesday, the 28th January.

Canvassing will disqualify.

WILLIAM TERREY,
General Manager.

Waterworks Office, Town Hall,
Sheffield, 9th January, 1930. 4188

The Institution of Structural Engineers

invite APPLICATIONS for the POST of SECRETARY.

Candidates must have had secretarial experience, combined with a general knowledge of the engineering profession ; competent acquaintance with modern languages is desirable in view of the Institution's present activities.

Applications, giving previous experience and stating salary required, must be addressed under sealed envelope to the PRESIDENT of the Institution of Structural Engineers, 10, Upper Belgrave-street, Westminster, S.W. 1, and the envelope must be endorsed in the top left-hand corner "Secretaryship—Private," not later than 31st January. 4285

The Isle of Man Harbour

COMMISSIONERS invite APPLICATIONS for the POST (unestablished) of ASSISTANT to the Isle of Man Harbours Engineer.

The commencing salary offered is £208 per annum. Applications, stating age, qualifications, experience and time required before taking up duty on appointment, accompanied by copies of three recent testimonials, must reach the undersigned on or before Wednesday, February 5th, 1930.

A. W. TONGUE,
Secretary.

Harbour Commissioners' Office,
Douglas, 14th January, 1930. 4237

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

BOX 4080.—The POSITION of ESTIMATING ENGINEER, advertised for under this Box No. on January 3rd, has now been FILLED. 4280 A

WANTED, DISTRICT REPRESENTATIVES for all parts of U.K. and Ireland on commission basis for sale of Patent Mixer for Concrete Cast Stone Tarmacadam, &c.—Address, A. EDWARDS, 12, Belgrave-road, C.-c.-H., Manchester. P6613 A

WANTED for Heavy Engineering Works Undergoing reorganisation, a WORKS MANAGER. Ability to handle men is of primary importance, good organising capacity, readiness to co-operate with the other departmental heads, and energy will be counted of greater value than actual experience of the company's manufactures. The job is a hard one, and only men fit and willing to put every effort into the work should apply in the first instance to P6608, The Engineer Office. P6608 A

BRITISH ENGINEERING FIRM REQUIRE experienced MAN to Undertake Entire Charge and Development of Established Pneumatic Tool Business. Salary and bonus £1500 to £2000, depending on results.—Address, 4232, The Engineer Office. 4232 A

CLERK OF WORKS REQUIRED by the Ham Urban District Council for a period of three or four months, to supervise Sewerage Contract comprising alterations to buildings and tanks and the erection of pumping machinery. Salary £6 per week.—Applications, stating age and previous experience and accompanied by copies of recent testimonials, to be sent to Messrs. WILLIAM FAIRLEY and CO., Consulting Engineers, Parliament Mansions, Victoria-street, Westminster, S.W. 1, not later than Saturday, 1st February, 1930. 4259 A

DESIGNER REQUIRED by London Firm of Structural Engineers. Must be competent and have had previous experience in preparing schemes for Theatres and Steel-framed Buildings. Knowledge of L.C.C. requirements.—Address full particulars in confidence, 4270, The Engineer Office. 4270 A

ENGINEER, 32-40, Energetic, with Practical and commercial steam-raising experience, REQUIRED as OUTDOOR REPRESENTATIVE in London on salary, commission and expenses basis.—Write fully to Box 709, Sells, Ltd., Fleet-street, E.C. 4. 4258 A

SITUATIONS OPEN (continued)

ENGINEER or METALLURGIST SALESMAN, to control London office of important British company marketing special alloys. A wide knowledge of technical industry with first-class education and address essential ; progressive position ; good salary with bonus on development. Only applicants stating full details of general and technical education and experience can be considered.—Address, "TECHNICAL," Wm. Porteous and Co., Advertising Agents, Glasgow. P6602 A

ENGINEER SALESMAN for Midlands District and Scotland, to sell specialties principally to steam users and heating engineers. Technical ability essential, previous selling experience desirable but not essential. State age, experience, and salary required.—Address, 4279, The Engineer Office. 4279 A

ENGINE TESTER WANTED, Experienced with Two-stroke Cycle Cold-starting Oil Engines up to 200 H.P. Man with drawing-office and outdoor experience preferred.—Box No. 242, Brown's Advertising Agency, 166, Buchanan-street, Glasgow. 4180 A

ENGINEERING SUPPLIES.
REQUIRED for Calcutta, capable REPRESENTATIVE for British concern. Public school education and organised selling experience on engineering lines essential. Age not over 28, single.—Write, with full particulars, to Box 14, c/o Foster Turner, Worcester House, Walbrook, E.C. 4. 4233 A

EXPERIENCED ESTIMATING ENGINEER, Accustomed to full responsibility for tenders, REQUIRED by Manufacturers of Turbo-generator Plant. Applicants should state age, training, experience, and salary required.—Address, 4193, The Engineer Office. 4193 A

FIRM of TOOL MERCHANTS and MILL FURNISHERS in Midlands are LOOKING for LIVE SALESMAN with sufficient personality and grit to open new ground. Practical knowledge an asset.—Address, 4284, The Engineer Office. 4284 A

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WORKS ACCOUNTANT REQUIRED, Accustomed to Supervision and Operation of Costing System on large Production Scale.—Write, stating age, experience and salary required, to 4288, The Engineer Office. 4288 A

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WANTED, for SPAIN, Experienced "Speed and Feed" MAN as FOREMAN of large Machine Shop. Must be thoroughly experienced and up to date on the working of all types of Modern Machine Tools.—Reply, stating age, whether married or single, and giving details of previous experience, to M. C., c/o Streets, Gracechurch-street. 4290 A

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Address, P6617, The Engineer Office. P6617 B

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ENGINEER (30), Cambridge Honours Degree, Works and commercial experience, travelled, possessing personality and energy, DESIRES APPOINTMENT, administrative or sales, with sound progressive engineering or manufacturing concern, preferably in London or Southern Counties. Prepared invest £5000 after trial and thorough investigation. Principals only write in strict confidence.—Address, P6615, The Engineer Office. P6615 B

ENGINEER, Just Returned from Abroad, Wide Experience in general and marine engineering practice and design ; also boiler and structural engineering design, DESIRES POSITION abroad or with Consulting Engineers. Age 35, capable taking charge drawing-office, or supervising work outside.—Address, WAITE, 11, Shirburn-avenue, Mansfield, Notts. P6607 B

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ENGINEER SALESMAN (40) DESIRES CHANGE. Works executive experience previous to commercial. Has covered Northern Counties for past ten years. Good sales records.—Address, P6612, The Engineer Office. P6612 B

EXPERIENCED ENGINEER and MANAGER REQUIRES POSITION as MANAGER or ENGINEER. M.I. Mech. E., keen and a good organiser, has had control of a large number of men. Excellent record. Future prospects the chief consideration.—Address, P6543, The Engineer Office. P6543 B

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PARTNERSHIPS

PARTNERSHIP.—CHARTERED CIVIL ENGINEER SEEKS a PARTNER. Competent in land drainage engineering.—Address, P6609, The Engineer Office. P6609 C

For continuation of Small Advertisements see page 4.

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A Seven-Day Journal

The Late Professor H. L. Callendar.

WE greatly regret to have to record the death at the beginning of this week of Professor Hugh Longbourne Callendar, Professor of Physics at the Imperial College of Science, London. Dr. Callendar was born at Hatherop in 1863 and was the eldest son of the late Hugh Callendar, of Magdalene College, Cambridge. He was educated at Marlborough College and at Trinity College, Cambridge, of which he was appointed a Fellow in 1886, and from which he received the degree of M.A. in 1888. In 1894 he was elected a Fellow of the Royal Society and two years later he was elected a Fellow of the Royal Society of Canada. From 1893 to 1898 he was Professor of Physics at McGill University, Montreal, and from 1898 to 1902 he occupied a similar post at University College, London. Professor Callendar will always be remembered for his work on the properties of steam, a subject on which he acquired a world-wide reputation and into which, by the adoption of thermodynamic reasoning, he introduced a degree of rationalisation which had previously been lacking. His Thomas Hawksley lecture on certain aspects of this subject, which he gave on November 1st, 1929, before the Institution of Mechanical Engineers, was a memorable exposition of its most recent developments. It was distinguished on the personal side by a characteristic but almost embarrassing modesty on the part of the lecturer when referring to his own great contributions to our knowledge of the properties of steam and water. We hope to refer to Professor Callendar's life and work in greater detail in next week's issue.

The Long Distance Flight Accident.

THE evidence gained by the Air Ministry officials who went out to investigate the loss of the long-distance monoplane at Tunis shows conclusively that there was no failure of the engine or aircraft. It is also certain from the log book, which has been recovered, that the occupants had kept exactly on their course and knew their position. The cause of the disaster is believed to have been that, owing to some unexplained circumstances which may include a failure of the aneroid, the pilot had reason to think that the aircraft was several hundred feet higher than it in fact was. There was a severe local storm in the area where the machine crashed, and it is believed that the pilot only saw the hill at the last moment and that in the endeavour to clear it the machine lost flying speed and dived into the ground just over the brow, an additional factor being possibly the down-draught caused by the prevailing wind.

The Pinkston Power Station Boiler Contract.

SOME time ago the Glasgow Corporation decided to obtain a report from an expert on the specification and tenders for the proposed installation of new boilers at the Pinkston power station of the transport department. Professor A. L. Mellanby, of the Royal Technical College, Glasgow, was duly asked to prepare the report, which has recently been issued. Tenders for the boilers were received from seven firms, and on the recommendation of Professor Mellanby, that of John Thompson Water Tube Boilers, Ltd., has been accepted. In view of the much higher price of pulverised fuel equipment and the problematical nature of the advantages to be gained from it, Professor Mellanby did not recommend the Committee to consider it. The firms that submitted tenders not differing widely in price were Babcock and Wilcox, Ltd., International Combustion, Ltd., John Thompson Water Tube Boilers, Ltd., and Yarrow and Co., and only the tenders of these firms were considered. A public protest meeting against the Glasgow Corporation Pinkston boiler contract being given to an English firm was held on January 19th at the Central Hall, Glasgow, by the National Party of Scotland.

The Coal Mines Bill.

BOTH the Federation of British Industries and the British Engineers' Association have this week issued official statements in which opposition is expressed to the provisions of the Coal Mines Bill. The British Engineers' Association objects to Government interference in the conduct of industry in general, and in this particular instance is "extremely apprehensive" of the effects of the Government's proposals on the engineering industry. It foresees in the Bill the cause of a diminution of our exports of manufactured goods and a consequent further increase in unemployment. The Federation of British Industries, following consultative meetings in all the leading industrial districts, is, now it says, in a position to state that the Bill is wholly unacceptable to the trade and industry of the country, and that it has aroused the gravest apprehensions as to its effect on the country's industrial well-being. The Federation is, by virtue of its constitution, not concerned with questions of wages, hours or conditions, and therefore confines its remarks on the Bill to its first part, which deals with the establishment of quota and coal-marketing schemes. It regards the proposals made in these directions as constituting examples of bureaucratic interference of a most vicious form, as lax in their definitions and as illusory in the safeguards to consumers which they are intended to provide. The League of Nations, the Federation points out, is at present engaged on an inquiry into the international aspects of the coal-mining problem. It is therefore reasonable, the Federation urges, that the Government should refrain from tying its hands by national legislation until the international situation becomes clear. Meanwhile, we note, the Government is likely to make some important amendments in the Bill when it is next debated in Parliament. It is probable that one modification will consist of postponing until next July the operation of that part of the Bill which reduces the miners' working day by half an hour. It is also apparently intended to limit the operation of the marketing schemes to an experimental period of 3½ years in the first instance, so that they may be reviewed by Parliament before being continued.

A Belfast Dock Scheme.

AT a meeting of the Belfast Harbour Board, which was held on Tuesday last, January 21st, it was decided to proceed almost immediately with the construction of a new dock on the County Antrim side of Belfast Harbour. The work, which will extend over three or four years, will be executed at an estimated cost of half a million pounds. Near to the proposed new dock, a large flour mill is to be built for Joseph Rank, Ltd., of Hull and London, and in connection with the mill two quays, one 420ft. long with a depth of 30ft. at low water and the other 180ft. long with a depth of 23ft. at low water, are to be constructed, which, on their completion, will become the property of the Harbour Commissioners. The remainder of the dock works, including the dredging of the new channel from the proposed dock site to the sea, will be carried out by the Harbour Board. When completed, the new dock will afford a quay length of 1020ft., having a depth of 30ft. at low water, and 1490ft. of quay having a 23ft. depth at low water. The land adjacent to the new channel will form valuable industrial sites, while the material dredged and excavated in the making of the new channel and dock will assist in reclaiming further land on the County Down side of the harbour. The work of dredging the new channel, which will shortly be begun, will mark the beginning of the large scheme, prepared by the Harbour Board for the purpose of laying out the port to the best possible advantage. The Government of Northern Ireland is supporting the new dock scheme financially, as a means for providing work for the relief of the unemployed.

The New P. and O. Liners.

AT the annual general meeting of the Peninsular and Oriental Steam Navigation Company, which was held last month, the Earl of Inchcape, the chairman of the company, referred to the early placing of an order for two electrically propelled passenger and cargo liners of about 20,000 gross tons for the company's Australian service. The order for these two ships has now been placed with Vickers-Armstrongs, Ltd., of Barrow-in-Furness, and the ships, which will take two years to complete, will be built at Barrow. The new liners will be slightly larger than the "Viceroy of India," and the maximum speed will, it is understood, be about 20 knots. The propelling machinery will consist of twin-screw turbo-electric equipment, each turbo-alternator being designed to give the ship the desired normal service speed. The electric propelling machinery will be manufactured by the British Thomson-Houston Company, Ltd., at Rugby, which firm will act in collaboration with Vickers-Armstrongs, Ltd. The boilers are to be of the latest Yarrow high-pressure, oil-fired type, and the boilers for the first ship will be built by Yarrow and Co., Ltd., at Scotstoun, while those for the second vessel are to be constructed at Barrow to the design of Yarrow and Co., Ltd. The main propelling and auxiliary machinery of the new ships will be generally in accordance with the installation on the "Viceroy of India," but it will include several new and interesting features, which have been adopted as a direct result of the very successful experience gained in the operation of the "Viceroy of India," which on the occasion of her last voyage, made a record run. The order is an important one for Barrow-in-Furness, and it is understood that an average of about 2500 men will be employed on the work.

Fires in Bunker and Cargo Coal.

IN a Journal note in our issue of September 27th last we dealt briefly with two fires which occurred on steamships fitted with combined systems of coal and oil firing, and outlined the instructions which had been issued to the Surveyors of the Board of Trade Mercantile Marine Department with regard to such installations. An interesting memorandum on fires which have occurred during the last three years in ships carrying coal either as cargo or in the bunkers has recently been issued by the Fuel Research Section of the Department of Scientific and Industrial Research. Data have been collected concerning 336 fires, which occurred on 272 ships, and the conclusions reached as to their cause are given, together with recommendations as to the precautions which should be taken in order to prevent such fires. Most of the fires were traced to avoidable causes, and the number of fires attributed to spontaneous combustion alone only amounted to 14 per cent. of those investigated. The inquiry shows that most of the fires which occur in steamships originate in the bunkers, and that in over half the cases examined the heating of the coal to the critical temperature was assisted by direct heat from the boilers, steam pipes and other sources. The suggestions made, which, if carried out, would, it is stated, reduce materially the number of fires, include greater care in loading and stowing the coal, the prevention of the external heating of the bunker walls, the mixing of different coals, and the prevention of air paths through the coal. The ventilation of coal bunkers is dealt with, and some recommendations are made with regard to the handling and stowage of specially susceptible coals, such as highly bituminous coals, German brown coal, and Silesian coals. For purposes of reference the existing instructions to Board of Trade Surveyors dealing with coal-carrying vessels are also given in an appendix.

New Ships for Canadian Railway Services.

AT the Govan yard of the Fairfield Shipbuilding and Engineering Company, Ltd., there was launched on Thursday of last week, January 16th, the new Canadian Pacific Railway coastal steamer the "Princess Elizabeth," which, together with her sister ship the "Princess Joan," now under construction, will be employed in the British Columbia service between Seattle and Skagway. The ships, which have a measurement of about 5000 gross tons, are 365ft. in length and 52ft. in beam, with a depth of 36ft. They are to be propelled by twin-screw quadruple-expansion balanced engines, with cylinder diameters of 16in., 23in., 33in. and 48in., and with a stroke of 33in. Steam for main propelling and auxiliary purposes will be raised in four single-ended oil-burning Scotch boilers designed to work at a pressure of 250 lb. per square inch. The boilers will be fitted with Howden air heaters and will operate under forced draught. The new ships will have well-arranged accommodation for passengers and cargo and motor cars. On Friday of last week, January 17th, there was launched at the Birkenhead yard of Cammell Laird and Co., Ltd., the "Prince Henry," the first of three fast turbine ships for the Pacific Coast Alaskan service of the Canadian National Railways. Each of these ships has a length of 384ft. 6in., a breadth moulded of 57ft., a depth moulded of 20ft. 2in. to the main deck, and a loaded draught of 16ft. 6in. The propelling machinery forms a good example of up-to-date high-pressure geared turbine practice. The twin-screw single-reduction Parsons turbines are supplied with steam from six water-tube boilers of the Yarrow type designed for a working pressure of 350 lb. per square inch with a superheated steam temperature of 650 deg. Fah. Auxiliary steam at 250 lb. pressure is furnished by two Scotch boilers. All the boilers are oil fired under forced draught, and the auxiliary equipment includes Weir regenerative condensers and turbine-driven feed and circulating pumps with a full complement of electrically operated auxiliaries.

Recent Orders for Oil Engine Propelled Tankers.

EARLY in the week orders were placed with British shipyards by the Anglo-Persian Oil Company, Ltd., for six large oil engine propelled tankers. The value of these orders, together with those recently placed by the company for oil refining equipment, storage tanks and general constructional work, amounts to close upon three and a-half million pounds. The new ships will operate on the service of the owner's shipping organisation, the British Tanker Company, Ltd. Three of the new tankers are to be built by Palmer's Shipbuilding and Iron Company, Ltd., of Hebburn-on-Tyne, and Doxford opposed-piston engines will be installed in all three ships, two sets of machinery being constructed by Doxford and Sons, Ltd., and one by Richardsons, Westgarth and Co., Ltd. The remaining three tankers are to be built on the Clyde, two being constructed by Lithgows, Ltd., at Port-Glasgow, and one by the Greenock Dockyard Company, Ltd., at Greenock. In these three ships Kincaid-Harland engines of the Burmeister and Wain type are to be fitted. It will be recalled that two other tankers were ordered late last year by the same owners and are now under construction at Messrs. Lithgows' yard. Among other recent orders for motor tankers we may mention that placed by the Anglo-Saxon Petroleum Company, Ltd., with Hawthorn, Leslie and Co., Ltd., for two oil tankers which are to be propelled by Hawthorn-Werkspoor engines fitted with the new Werkspoor supercharging arrangement. The Anglo-American Oil Company, Ltd., has also under construction at Palmer's yard two oil tankers of large capacity in which Doxford opposed-piston type engines are to be fitted. During the past week the Blytheswood Shipbuilding Company, Ltd., of Scotstoun, announced that it had received an order for a large oil tanker for American owners, which will be propelled by Kincaid-Harland oil engines.

Links in the History of the Locomotive.

BLENKINSOP LOCOMOTIVES AT THE KENTON AND COXLODGE COLLIERIES, 1813–1815.

By E. A. FORWARD.

No. I.

THE early history of the Blenkinsop rack locomotives at the Middleton Colliery, near Leeds, and the technical details of their construction as revealed by the available evidence, were fully dealt with in THE ENGINEER, Vol. CIX., 1910, page 432.

The fact that similar engines were employed for some time at the Kenton and Coxlodge Collieries, near Newcastle, has long been known, but the only contemporary evidence about them which was available consisted of paragraphs in the Newcastle newspapers reporting that one started work on September 2nd, 1813; and Blenkinsop's own statement—apparently made in 1814—published in the "Repertory of Arts" in 1818, to the effect that his engines had "been in use at Middleton Colliery, near Leeds, belonging to John Brandling Esq. since June 1812; also at Wellington Colliery, John Watson Esq.: at Orrel Colliery, near Wigan, Lancashire; Kenton and Coxlodge Collieries, near Newcastle, Northumberland." In this statement the name "Wellington" is probably a misprint for "Willington," where John Watson lived.

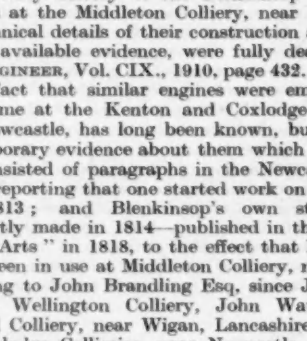
It is well known that, when making researches in engineering history, we rarely find contemporary records of their work left by the individuals concerned, and we generally have to rely on information given by others, frequently at a much later date, and therefore much less valuable as authentic evidence. Watt and Trevithick are, of course, exceptions, but even in the case of the latter his correspondence, which still existed in 1870, has since disappeared. It is, therefore, with particular pleasure that we are able to remedy the deficiency in at least one case by placing before our readers the contents of some recently discovered letters, written by John Blenkinsop and Matthew Murray to John Watson, dealing with the introduction of the Blenkinsop engines on the Coxlodge wagon way, and incidentally supplying new information about the Leeds engines. These are believed to be the only Blenkinsop letters so far known, and the only letters by Matthew Murray which deal with this subject.

John Watson was a colliery viewer resident at Willington, near Newcastle, and in 1813 he appears to have been a partner in the Kenton and Coxlodge collieries. He was evidently responsible for the introduction of the first working locomotives in the Newcastle district, and it was his observation of these engines which led George Stephenson to construct his improved locomotives at Killingworth.

Watson appears to have been an indefatigable collector of material relating to the collieries in the Newcastle district, and this is now preserved in the Library of the North of England Institute of Mining and Mechanical Engineers at Newcastle, by the permission of which we are able to publish the Blenkinsop and Murray correspondence.

Before dealing, however, with the Kenton engines, a point in connection with the Leeds engines must be mentioned. The first published account of these locomotives appeared in the *Leeds Mercury* on June 27th, 1812, where it is recorded that an engine started work on June 24th. This notice is well known; but, three weeks later, another and little-known paragraph appeared in the same paper, accompanied by a woodcut of the engine, which must be the earliest illustration extant. The paragraph and drawing were copied into a Newcastle paper of August 1st, 1812, and this illustration, which is to the scale of ⅛in. to a foot, is reproduced in Fig. 1. The paragraph is as follows:—

"In our Paper of the 27th ult., we mentioned a successful Experiment made on the Iron Rail-way



DESCRIPTION OF THE PLATE.

A. *Boiler.*
B. B. B. *Mr Blenkinsop's Patent Road Rack and Wheel.*
C. C. *Crank Rods.*
D. D. *Steam Cylinder.*
E. *Discharging Pipe.*
F. *Smoke Chimney.*
G. *Fire Door.*
Scale, 1-eighth of an Inch to one Inch.

FIG. 1

between Hunslet and Leeds, to ascertain the Powers of a Steam-impelled Machine, by which the Conveyance of Coals, Minerals, and other Articles is facilitated, and the use of Horses dispensed with. This Machine, at once so simple, powerful and beneficial, has, as was to be expected, excited a considerable Share of Public Attention, and we subjoin a Drawing of the Machine and Toothed Rail-way, accompanied by an Abstract of the Specification of the Patent granted on the 10th of April, 1811, to the Inventor Mr. John Blenkinsop, of Middleton, near this place."

The engine depicted is generally similar to the later engravings, but its boiler is proportionately smaller. It shows the same peculiarity as exists in the French drawing of 1815, reproduced in Vol. CIX., page 432, namely, that the two connecting-rods appear to be connected with cranks at 180 deg. with one another, and not at 90 deg.

Turning now to the newly discovered letters, we will give them in chronological order, commenting on them where necessary.

The first is from Blenkinsop addressed to John Watson at Willington, near Newcastle.

Middleton, nr. Leeds,
Aug. 2nd, 1812.

"I write to inform you that my Patent Steam Carriage is daily at work and is capable of moving 20 coal waggons each weighing 3½ tons at the rate of 3½ miles an hour=74 tons including the weight of the machine.

One journey with 20 waggons (1½ miles each way) was performed in 50 minutes.

The quantity of inferior coals used in 12 hours is 10 cwt.—45 cwt. of the same coals would sell for 12/6—therefore the coals consumed in all 2/9 per day.

The water used per hour is 9 solid feet or 55 gals. —but in consequence of letting off the steam to charge and filling with cold water each journey, will require more fuel and water than if boiling water was put into the boiler by means of a force pump or elevated cistern. I intend to feed with hot water tomorrow but it will be a week or ten days before I can raise a cistern so as to fill the boiler without discharging the steam. After another week's performance, I shall inform you of our success.

I am
Dear Sir
Yours very truly,
Jn° BLENKINSOP."

A photograph of the end of this letter with Blenkinsop's signature is reproduced in Fig. 2. This letter reveals the fact that the engine at that date, five weeks after it started work, was not fitted with a feed pump and the steam had to be let out in order to replenish the boiler. Blenkinsop was actually contemplating raising a water tank some 120ft. high to refill the boiler without letting down the pressure. This is surprising, as Trevithick's high-pressure stationary engines of the period were normally fitted with feed pumps.

Over three months intervene before the next letter, which was written by Blenkinsop to Watson.

Middleton, Nov. 12th, 1812.

"Dear Sir,

Enclosed I hand you my estimate for conveying the Coals from Coxlodge and Fawdon Collieries by horses and Steam Carriages. You will be very much astonished at the savings in favour of the latter way of conveyance, yet I trust you will find both pretty near correct. Should the owners of these collieries think it advisable to adopt this method of conveying the coals, I shall be very happy in allowing you ⅛ part of the Patent right paid by them for your superintendence of the business.

I am dear sir
your obedient and obliged serv't
J. BLENKINSOP.

The expense of keeping a horse I am persuaded I have kept considerably within compass.

1 horse will cost in a year 4 tons of hay @ 5..	20
Summers grass	5
2 Bushels of oats in a week=104 @ 7s.. ..	36 . 8
½ Bushel of Beans a week=26 @ 13/-	16 . 18
	£78 . 6 . 0 p.a.

I have only reckoned at £50 as I dont suppose the prices to continue so enormous. J. B."

The estimate which accompanied this letter is as follows:—

"Estimate for conveying 60,000 chal[rs] of Coals 5½ miles by Patent Steam Carriages calculating the engine to take 16 chaldrons and perform three journeys per day; will require 5 engines and one man to each engine at 25/- per week each, rate per annum	£325
1 engineer per an ..	100
6 men, house & fire coal @ £6 . 10	39
Coal, tallow & oil, 5 engines at £50	250
Wear and tear of engines supposed at ..	300
4 horses to be kept to remove the empty waggons from the engines @ £50	200
Gear for ditto 3 guineas each..	12 . 12 . 0
4 mens wages at 18/- per week each	187 . 4 . 0
House rent & fire coal for do.	26 . 0 . 0
Farriers wages, drags and shoeing the 4 horses @ 1/- each per week	10 . 8 . 0
Decay of horses..	18 . 0 . 0
	1468 . 4 . 0
Deduct for manure bred by 4 horses	10 . 0 . 0
	1458 . 4 . 0

Expenses of leading by Patent Steam Carriages exclusive of the Patent right=5½ per Chaldron."

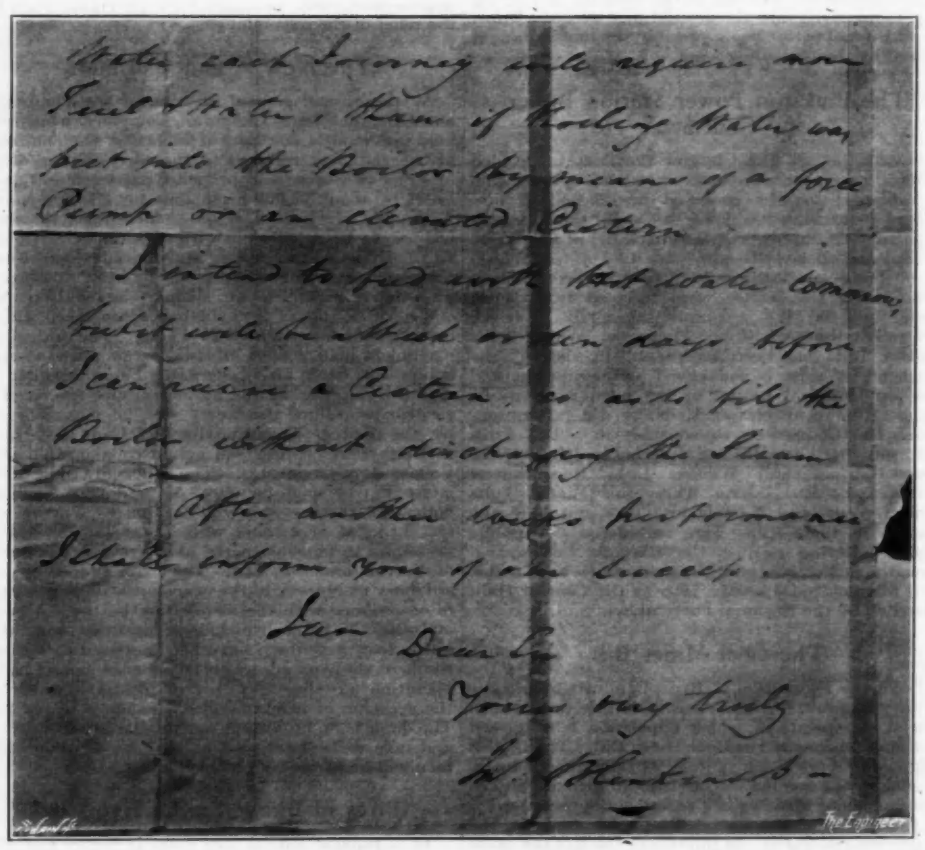


FIG. 2—FACSIMILE OF END OF LETTER FROM BLENKINSOP TO WATSON

Then follow the detail costs of horse haulage, which amount to £9453 13s., or 3s. 1¾d. per chaldron. Eighty-one horses were required to do the same work.

"difference in favour of engines £7,995 . 9 . 0 per annum. From my estimate it appears that the coals will be led at £300 each engine which includes

horses &c, but I think the expence will not exceed the following—

one man	£60 per an.
Coals	40
oil & tallow	10
wheels	20
Grate bars	10
	£140
Deduct for old metal	10
	£130 per annum.

I am not aware of any other expenses provided no accident happens to the engine and should the coals be led at night as well as by day, three engines will be capable of conveying 60,000 chaldrons.

The Patent right at £10 per cwt is £800 per annum. Boulton & Watt's charge was 33⅓% per annum, or one third of the savings."

From this estimate it appears that the cost of haulage by engines would be only one-sixth of haulage by horses, but it should be noted that the cost of laying the rack rails is not included in the estimate. The proposed Royalty of £800 per annum, per engine, would swallow up half the estimated savings.

The next letter, from Blenkinsop to Watson, is dated :—

Jan. 6th, 1813.

"Dear Sir,

I beg leave to apologise for my not writing you before I left the North, but I hope you will pardon me as I was so much hurried the day before I took my departure.—I trust you will not think me out of the way in asking £50 per annum for the use of the Patent Steam Carriage from Coxlodge or Fawdon Colliery (whichever colliery you choose) to the Wooden Bridge at Hadericks Mill, should you accept this proposal I must beg leave to request the carriage to be put in motion by the middle of next June and the road to be a regular and well laid way—with a rail of sufficient strength to bear the weight and pressure of the steam carriage.

I am dear sir,
Yours truly,
J. BLENKINSOP."

It will be observed that Blenkinsop's suggested Royalty had been reduced to £50 per annum, presumably for each engine. The former figure would no doubt be the reverse of encouraging to prospective users of the engine.

The next letter is from Matthew Murray to John Watson, who was then at Easty's Hotel, Covent Garden.

Leeds, March 8th, 1813.

"Sir,

I am favoured with yours this morning and observe the contents.—Beg to observe that the objections I made were the same as I informed you of in mine of July last to which please refer. Since then Mr. Blenkinsop has found it his interest to attend to his iron rails—I have improved the mode of joining them together which has made them both simple and perfect and the engines themselves answer much beyond our expectation which I have no doubt in saying is the most valuable improvement to the Colliery Business that has been made these 50 years. Particularly for Pits that are situated a considerable distance from the sea and where the expense of horses and keep is a considerable drawback from the profits of the Coals.

The plan I should most approve of would be to have the rack in the centre of the Road and where Roads are already constructed the addition will not be more than £700 per mile—A statement of the cost of engines compared with 40 horses is on the other side—The wear and tear of engines will not be more than the wear and tear of the horses.—Should you and your partners conclude to adopt the principle I will wait upon you at Newcastle to con ult with you respecting carrying it into effect and making the necessary arrangements.

I remain
for Fenton, Self and Wood
yr Obedient Servant
M. MURRAY."

Cost of 40 horses @ £50 per horse	£2,000
Do of 5 engines to do the work of 40 horses. Two engines supposed to be always standing, one cleaning and the others ready will be	£2,000
Annual cost of 40 horses including, Shoeing, Gearing, Farriery & Stabling, £55 per horse ..	£2,200
10 Mens wages including coals and houses—Rent, say £50 each	£500
10 Boys suppose 8/- pr. wk. say 50 wks.	£200
	£2,900
3 Mens wages to go with the engines including coals and house rent say £60 per an...	£180
One smith to clean and repair including coals, house and shop rent. £80 per an.	£80
Coals for 3 engines constantly working £50 pr year each	£150
Cost of 3 miles of Additional Rack Rail £2,100 allow 20% per an.	£420
	£830
And saving by Mr. Blenkinsop's Patent of	£2,070

Murray's previous letter of July, 1812, has not come to light. This letter is interesting as showing that Murray actually preferred a central rack to a side rack. His estimate makes the cost of engine haulage 0·29 of that of horse haulage, but he includes the cost of the rack rails.

The next letter is from Blenkinsop.

Middleton, March 23rd, 1813.

"Dear Sir,

Your favour of the 21st. I this morning received and if you are really inclined to use the steam carriage I shall grant you a licence to be used for conveying the coals wrought by the Kenton owners to the river for £200 per annum. I have contracted with a gent for £50 per mile per an. I am in treaty with three others for a larger premium, this sum I think you cannot possibly object to after considering the great expense I have been at and the difficulties I have surmounted in bringing it to perfection.

The third engine which is now in hand for this place is nearly completed and you are very welcome to it—you will find it a very great advantage in laying your road regular and firm. It will be necessary for you to send the width of the road and the breadth of the surface of the rail so that the engine may be fitted up to suit.

Chapman's plan is only a mechanical (fallacy). I will thank you for a description of it if you know his scheme. When I hear from you I shall send you a rail and pedestal by road waggon if you ask it.

I am dear sir
yrs truly
J. BLENKINSOP."

This letter confirms the statements that there were, by this date, two engines at work. A third engine for Middleton was nearly complete and was offered by Blenkinsop to Watson. Chapman's locomotive system, which had been patented in December, 1812, was evidently known to them, although no engine was yet in use.

The next item is a sheet dated Leeds, 5th April, 1813, and was probably an enclosure with another letter from Blenkinsop; it is a form of agreement for the use of the engine.

"Mr. Blenkinsop agrees to allow to the owner of Kenton and Coxlodge Collieries the use of his mode of leading Coals by virtue of steam engines. The owners paying him for such liberty for the first year commencing 1st Jan. 1814, fifty pounds, and for the following years one hundred pounds while they use it during the continuance of Mr. Blenkinsop's Patent Right."

On the same sheet are some notes apparently written by Watson as follows :—

"Weight of common rail per yard 46 lb. including pedestal
do. of cogged rail 64 lb. including do.
Weight of Engine including water 5 tons

The engine will go 5 miles without filling the boiler. Mr. Blenkinsop to have the width of our way sent him also breadth of the top of our present rail 55 lb. pressure upon every cubic inch.
Price of Engine £350."

On April 12th, 1813, Blenkinsop again writes to Watson as follows :—

"Dear Sir,

I waited on Mr. Bradley at Kippax yesterday and had some conversation with him on the subject of your intended road. He will not suffer the line to go east of the Church but I think will not object to the road being made some way near as you will see it on the sketch which does not appear to be a great turn; however, to accomplish the object he wishes you to wait upon him at Gosforth on Tuesday the 27th. inst. in the morning and to desire Mr. Robson, one of his tenants, to be there at the time. He expressed a hope that the business would be settled the first meeting, it would therefore be necessary to have the Plan made on a larger scale with your intended line of road, proposed alteration of the old road, in readyness. I hope you have wrote to Murray respecting your engine, as he would rather make an entirely new engine for you, but now it will be necessary to urge him to proceed with despatch.

I am dear Sir
yours very truly
J. BLENKINSOP.

I shall shortly have a regular bill drawn up for the Patent and will send yours down."

Then follows an extremely interesting and technically important letter from Murray to Watson :—

Leeds, April 17th, 1813.

"I have your obliging favour and should have been glad to have seen you at Leeds if your time would have permitted as many things relating to this business might have been explained by a personal interview.—I am going into Scotland by way of Carlisle next week, cannot tell exactly how long it will take me, or should have waited upon you.

I perceive by yours Mr. Blenkinsop has made you an offer of the engine we are making for him, as a spare engine for his present rail road which is quite necessary where two is required to work constant.—At present they are at a stand for repair when anything happens, which creates a deal of confusion.

However, if Mr. Blenkinsop can spare it I have not the least objection, although I beg leave candidly to observe it is not the kind of engine I should recommend for your purpose, as the boiler is calculated only for Mr. Blenkinsop's short distance and in course will require more time refilling with water on yours. Another objection is the rack wheel being fixed on one side of the road instead of the middle, this causes the wheels of engine to wear away very fast, and proportionately the rails and this I am afraid we shall discover to a greater extent than is imagined.

I make these observations for you to consider of in beginning the business as you know it cannot be altered afterwards without being at an enormous expense and in short beginning over again—which will be the case here I believe before they can expect to run to the pits as the oblique action or side pull is very determinal in going up a moderate rise or turning. The side rack did very well as a cheap method for trying the scheme, but certainly is not calculated for practice. From these remarks you will be enabled to determine which method you will pursue. Can inform you that the present engine will be finished in about 6 weeks or 2 months from this time. The price will be £350 delivered here and payable 2 months from delivery by Bill at 2 months.

We set them to work and try them prior to delivering them—We are casting Mr. Blenkinsop some iron rails at present, they are for the side rack principle which if you think proper we will send you two of them to look at together with the chairs which is 14/- per cwt., and I believe is the best form and proper strength for bearing the weight of these engines.

We are at present very busy in the Engine Department, and by the Death of Mr. Lister having to pay out his Capital (which is considerable) and with an increased stock of Engines on hand makes it necessary for us to shorten our credit as much as possible. I had some thoughts of making these engines with wrought-iron boilers instead of cast-iron, this will lessen the weight and increase the quantity of water; they may also be made with one cylinder to draw 10 or 12 waggons where the ground is totally level, this will materially simplify them and lighten the cost and enable the engine to go a greater distance with one charging of water.

Your opinion of these remarks will much oblige
For Fenton, Self and Wood
Your obedient servant,
M. MURRAY."

Here Murray emphasises his objections to the side rack. The letter shows that he himself was casting rack rails, and that the first three engines made had cast iron boilers, but that he was contemplating the use of wrought iron. What seems rather extraordinary is his suggestion that a single-cylinder engine might be used where less power was required; this would lead one to suppose that Murray, at that date, did not appreciate fully the virtues of two cylinders working cranks at right angles, which arrangement he is credited with having originated for the locomotive. The firm had, however, started its experiments with a single-cylinder engine.

(To be continued.)

Newcastle-Gateshead New Road Bridge.

WHILE it was under construction and when it was completed we published articles* describing the new road bridge over the Tyne between Newcastle and Gateshead, which was opened by his Majesty the King on October 10th, 1928. By the courtesy of Messrs. Mott, Hay and Anderson, of Westminster, to whose designs, in conjunction with Messrs. Coode, Fitzmaurice, Wilson and Mitchell, the bridge was built, we are enabled to give in our Supplement of to-day a series of drawings of various parts of this interesting structure.

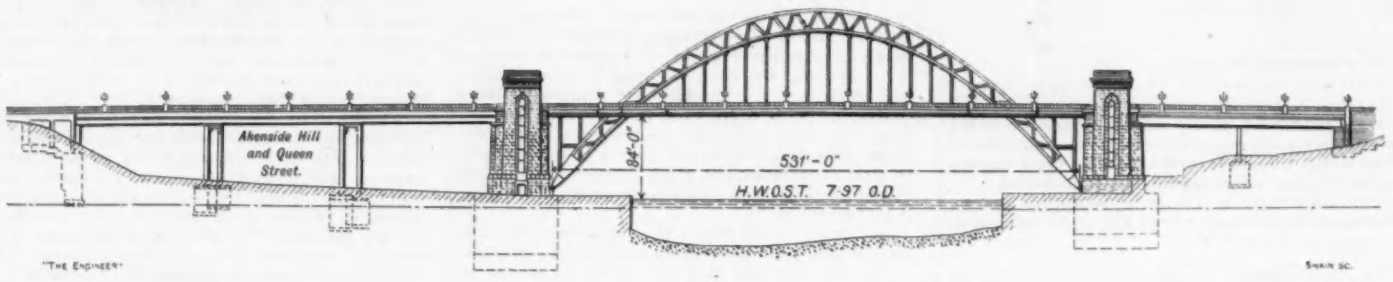
The bridge is noteworthy in several respects. It is, for example, the largest arch bridge in the country, its span being 531ft. from pin to pin, and its rise is 170ft., while there is a clear height for shipping of 84ft. between the level of high water of spring tides and the underside of the sub-structure of the roadway. The latter is suspended by hangers from the lower booms of the ribs, except towards each end, where it is carried on columns resting on the upper booms of the ribs. Furthermore, the method devised for the erection of the arch was ingenious and entirely successful.

An outline of the bridge and its approaches was given in our issue of December 30th, 1927, and it is reproduced to-day. Furthermore, in order to make the present article complete in itself, other particulars which have appeared in past issues are included in it.

The arch, which is of mild steel, is of the two hinged type. It consists of two crescent-shaped ribs arranged at 45ft. centres. A diagram of the main arch steel work is given in an engraving on the next page. As will be observed from the drawings, each rib is composed of upper and lower booms of parabolic

* See THE ENGINEER, December 30th, 1927, and February 24th and October 12th, 1928.

NEW ROAD BRIDGE BETWEEN NEWCASTLE AND GATESHEAD



outline, with single bracing of the Warren type. The depth between the booms at the centre is 20ft. 3in. The ribs are connected by lateral and sway bracing, the lateral bracing being in " K " formation.

The arch ribs were built out simultaneously from all four hinges. In our issue just mentioned was given a set of diagrams illustrating the various stages of construction. Our readers will remember that, in the initial stages, this work was effected by the use of a cradle on which the ribs rested. As erection proceeded, the weight of the ribs was transferred from the cradle to cables which were connected to the top booms. These cables were carried back over temporary masts erected on the river ends of the approach spans, and connected to the webs of the approach spans. The cable tension was resisted by the dead-weight of these girders in conjunction with raking struts, which were provided to prevent the girders being dragged riverwards. The point of attachment of the suspending cables to the top booms was only altered once during the progress of the erection.

When the two halves of the bridge, rising from each side of the river, had been completed with the exception of the centre panel of the lower boom of the arch ribs, the cables were slackened off so as to allow the top chords to meet, a temporary pin being inserted to transfer the thrust between the two halves of the upper chords. At that stage the arch was, actually, three-hinged. The centre panels of the lower chord were then raised into position, and, by means of hydraulic jacks, a definite compression was applied between that member and its adjacent chord, so as to put the arch into a true two-hinged condition. After the insertion of carefully-shaped fitters and the completion of the jointing, the jacks were removed.

The foundations for the abutments, which take the thrust of the steel arch—one being arranged at each of the four feet of the arch—were taken down to solid rock which was found at — 40 O.D. on the Gateshead side and at — 60 O.D. on the Newcastle side, high water of ordinary spring tides in the river rising to + 7·97 O.D. The foundations, which were sunk by means of caissons under compressed air, consist of four masses of concrete measuring 84ft. 6in. long by a width—taken at right angles to the centre line of the arch—of 28ft. They vary in depth from 60ft. to 80ft. overall. Between quay level and bridge roadway level these abutments are of steel and concrete construction, faced with granite. The towers thus formed are hollow and measure some 100ft. long, 60ft. wide, and 90ft. high. Further extensions upwards consist of towers on each side of the bridge, which rise to a height of nearly 40ft. above the level of the road. Stairways and lifts afford access between quay level and the bridge roadway.

The approach to the bridge on the Newcastle side begins in Pilgrim-street, while that on the Gateshead side ends in a direct line with High-street. The gradient of the Newcastle approach is only 1 in 66·4, while that of the Gateshead approach is even less steep, being only 1 in 91·5. The length over the actual arch is graded to a very flat parabolic curve. The approaches on each side are carried by continuous longitudinal girders, supported on steel columns, and are spaced at 34ft. centres. The spans vary from 100ft. to 154ft., it being impossible to space the supporting columns at even distances apart, owing to the incidence of adjacent buildings and streets. The main girders are of twin plate web form, and measure 11ft. 6in. deep over angles. The supporting columns, which are octagonal in section, are built up with a skin of steel plates, strengthened by rolled steel joists, and filled in with concrete. Earth approaches, retained by concrete walls, partly masonry-faced, have been provided on each approach between previously existing street surfaces, and the continuous girder spans. This construction extends for, approximately, 200ft. on each side. The continuous girder spans were launched into position by rolling out from the earth approaches. As rolling proceeded, further sections were assembled on the earth approaches and riveted on to the preceding sections. In order to decrease the difficulty of bridging the span between the columns during rolling out, the deck steel work carrying the roadway over the abutment towers was used as a nose to the girders, and this nose was supplemented by a light steel framework at its extreme end.

The width of the carriageway is 38ft., and there is a footway on each side with a clear breadth of 9ft. In the carriageway there are two tramway tracks, which connect the tramway systems on each side of the river. In view of the heavy nature of the traffic which may be expected to cross the bridge, because of the industrial nature of the area, the structure has been made exceptionally strong. In addition to the standard Ministry of Transport loading, allowance has been made for an exceptional load of 100 tons on four wheels. The level of the surface of the highest point in the roadway comes 93ft. above the level of high water in the river. The carriageway is surfaced with wood block paving, resting on concrete, and the footways are of tarmacadam. Over the arch and continuous girder spans the surface rests on buckled steel plates supported on cross joists and longitudinal stringers, which, in turn, are supported on the cross girders. The footways are carried on brackets cantilevered out from the cross girders.

The contractors for the work were Dorman, Long and Co., Ltd., of Middlesbrough, and the erection scheme was got out by them to the design of their consulting engineers, Mr. Ralph Freeman and Mr. G. C. Imbault.

In conclusion, we desire to express our indebtedness to Messrs. Mott, Hay and Anderson for furnishing us with the drawings with which this article is illustrated, and with the particulars from which the text has been prepared.

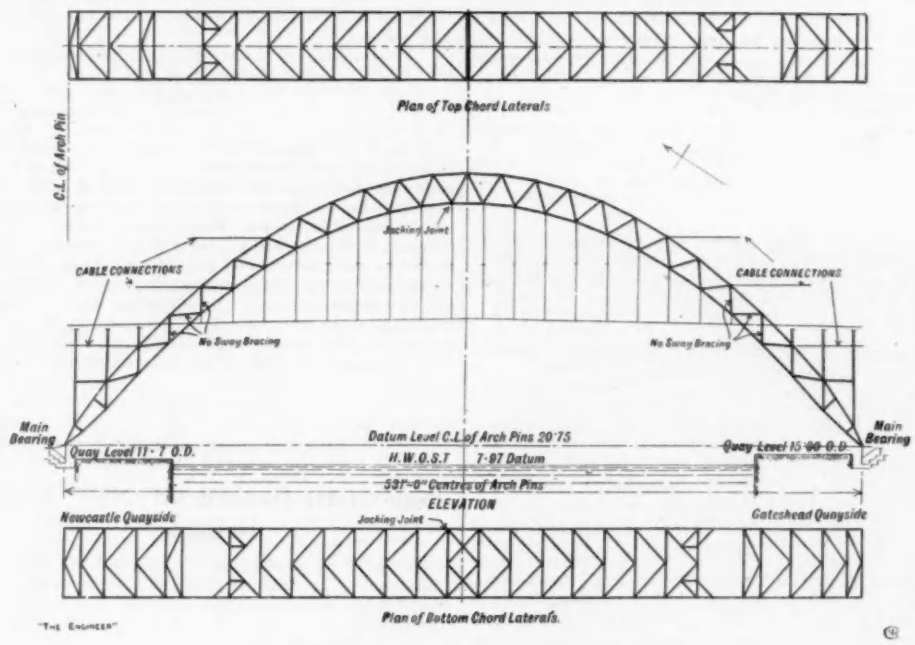


DIAGRAM OF MAIN ARCH STEELWORK

The Physical and Optical Societies' Exhibition.

No. III. (*conclusion*).*

AMONG the exhibits of the Royal Aircraft Establishment was a portable experimental calibrator for air speed indicators, for quickly checking the accuracy of air speed indicators on aircraft. It consists of a sharp-edged valve bearing on a flat seating and loaded with weights appropriate to the required pressure. A damping cylinder forming part of the valve prevents it from chattering. A valve of this type, when caused to lift slightly from its seating by a flow of air, gives rise to pressure differences which depend on the applied load and are affected only to a small extent by variations in the density and rate of flow of the air. The low-pressure side of the valve is open to the atmosphere, and the other side communicates with air supply and the pressure side of the instrument to be checked. The air supply may be from the operator's mouth for air speed indicators up to 240 m.p.h.

Another exhibit was the experimental pneumatic revolution indicator, shown in Figs. 18 and 19,

FIG. 18—PNUEMATIC REVOLUTION INDICATOR—R.A.F.

designed primarily to replace the standard flexible drive type of engine speed indicator on aircraft, in which the engine is far removed from the pilot's cockpit. Long flexible drives have proved unsatisfactory on account of the fact that they cause unsteadiness of the pointer and frequently break. The principal part of the instrument is the valve unit shown in section in Fig. 19. The barrel-shaped part A is rotated at engine speed in the ball bearings B and C by a very short flexible shaft attached at D. The sharp-edged cylindrical valve E, composed of duralumin, houses a damping piston F and bears on a flat seating G, which screws into and can be locked to the part A. The screw H carries the balance weight J and serves as a stop to prevent the valve E from falling too far away from its seating

* No. II. appeared January 17th.

when the instrument is not operating. The outer casing K carries an air filter L of gauze and cotton wool and a nipple P. The part M, which screws into the casing K and carries two nipples V and S, is adjusted until there is a small clearance between its conical part and the grooved part of A, and there is a small continuous air leak at this point during operation. The complete installation includes a Venturi tube placed in the slipstream of the air screw and connected to the nipple V, and a pressure gauge with its dial marked in r.p.m., according to an arbitrary square law, which is connected to the nipples marked P and S. The seating G is adjusted radially so that the same arbitrary square law holds for the valve unit. When the instrument is operating, the valve E tends to be pressed on to its seating by the centrifugal force due to its own mass. The suctions given

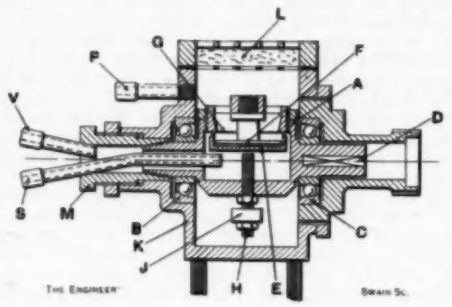


FIG. 19—PNEUMATIC REVOLUTION INDICATOR—R.A.F.

by the Venturi, however, are sufficiently great, except at very great altitudes, to lift it from its seating, but, as soon as that happens, the pressure gradient due to the resultant flow of air in the piping to the Venturi and in the Venturi itself causes the pressure difference across the valve to be diminished until it balances the centrifugal force and the valve takes up a radius of equilibrium. This is an inherently unstable system, and the valve would continuously oscillate in the absence of the damping piston F. The pressure gauge gives a reading which depends on the pressure difference across the valve as obtained from the nipples P and S. Regarding the valve as a piston at constant radius of rotation, it can be seen that when the valve is in equilibrium, this pressure difference will be proportional to the square of the speed of rotation. Actually, the decrease in radius of rotation of the valve due to lift is balanced by a diminished effective area, so that the large changes in air flow given by the Venturi do not

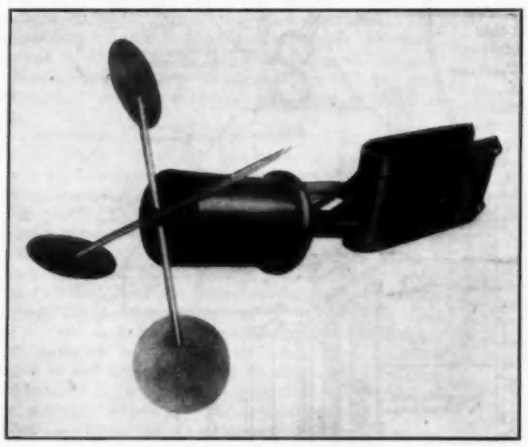


FIG. 20—AIR SPEED INDICATOR—R.A.F.

greatly affect the pressures obtained at various speeds. The maximum error of the whole instrument when tested in flight was 16 r.p.m. for speeds from 600 to 2000 r.p.m.

An experimental rotating vane air speed indicator, as illustrated in Figs. 20 and 21, was also shown. The standard pitot tube air speed indicator gives a reading which is proportional to $V\sqrt{\rho}$, where V is the true air speed, neglecting the position error, and ρ the density of the air. For ordinary flying purposes this pitot instrument is preferable and simpler than one giving true air speed, mainly because the dangerous stall occurs at a definite value of $V\sqrt{\rho}$, and hence at a definite value of indicated air speed for all altitudes. For certain purposes, however, true air speed is required, and in order to avoid the necessity for calculating it from the above formula, the rotating vane instrument has been devised. It consists essentially of a windmill having very small bearing friction, coupled to the pneumatic revolution indicator, as described above. It replaces the standard pitot head, but can be used with the same pressure instrument. Fig. 21 shows a sectional view of this instrument. A is the windmill consisting of four flat discs mounted on two rods passing through the spindle B, which is attached to the hub C which runs on two ball bearings on the fixed shaft D attached to the main body E. The hub C carries a shell G, air filter H, valve J, seating L, damping piston K, and balance weight M. The shaft and body are drilled so that communication is established between the nipple S and the inside of the hub C. The nipple P communicates with the space in the mouth of the shell G, and the nipples P and S are connected to the pressure gauge in the cockpit. The outer tube N, which is supported by three

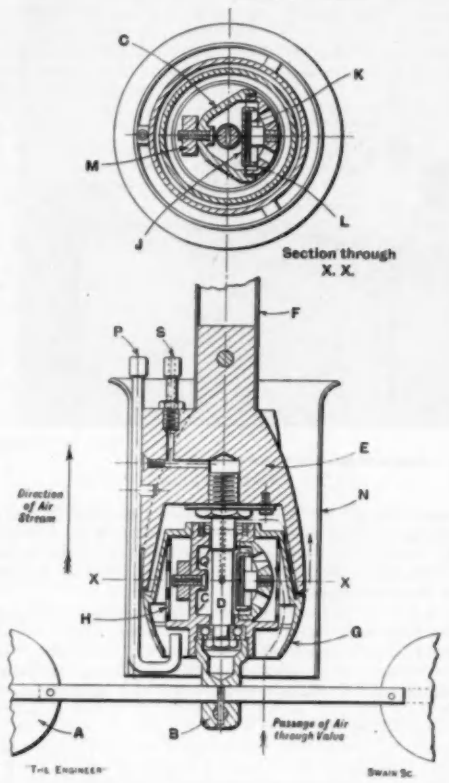


FIG. 21—AIR SPEED INDICATOR—R.A.F.

webs of the body E, forms the outer member of the Venturi tube. F is a steel tube terminating in a clamp to fit the strut of the aeroplane. The duralumin valve J is machined to a dead sharp edge, where it makes contact with the seating, and is then ground on a flat surface, so that the sharp edge is reduced to a flat about 0·005in. in width. The piston K is a good sliding fit inside the valve and serves as a guide in addition to the more important function of preventing the valve from continuously oscillating, and so causing large errors and wear of the valve edge. The dotted arrow shows the passage of the air past the air filter, valve, rear bearing, and so to the throat of the Venturi. The flow of air is restricted by the small clearance at Q between the hub C and shaft D. The air filter H consists of a tube drilled with holes and lined with the finest mesh wire gauze. This is of such an area that the drop in pressure as the air passes through the filter is negligible, and the pressure measured at P may be taken as the pressure acting on the outer side of the valve.

Other exhibits of the Royal Aircraft Establishment were an experimental accelerometer, an experimental angular accelerometer, an experimental alimeter, and various types of cameras. The engravings relating to the Royal Aircraft Establishment's exhibits are reproduced from R.A.F. photographs, of which the Crown copyright is reserved.

In the research section, Mr. E. B. Moullin, of Cambridge, was showing a new form of variable condenser of small capacity, suitable for precise measurement at very high radio frequencies. It is intended primarily for measurements at frequencies such as 3×10^7 cycles per second—$\lambda=10$ m.—and consists of two circular cylinders with parallel but not concentric axes. The inner cylinder is carried on an axle which is excentric both with the outer and inner cylinder, and when this is rotated the distance between the axes is altered with a consequent change of capacity. The first 47 deg. of scale correspond to an increase of capacity of 1 $\mu\mu$F; and a further 17 deg. causes a further increase of 1 $\mu\mu$F.; the total available change being 16 $\mu\mu$F. Two mica condensers, each 16 $\mu\mu$F. capacity are contained in the base chamber, and these increase the total capacity in three steps to a maximum value of 70 $\mu\mu$F.

Features of the design are the robust construction, which gives great permanence of calibration; a calibration which can be calculated precisely; and a geometrical form for which the residual inductance can be both measured and calculated. The same instrument can also be used as a small variable inductance of an approximate maximum value of 0·1 μH.

The Aerodynamics Department of the National Physical Laboratory was showing apparatus for the detection of turbulence in the boundary layer of an airship model. When an airship model is supported in an air current the retarding influence of the model on the air flow is mainly confined to streams lying within a wedge-shaped region of which the surface of the model forms the inner boundary. This so-called boundary layer begins at the nose, where it is indefinitely thin. As it extends backwards, however, towards the tail, the thickness increases with the distance, though not at a uniform rate. In the forward part of the layer the flow tends to assume the characteristics of laminar motion; but at some position dependent upon the shape of model, speed and the general steadiness of the air current, a breakdown occurs which causes the flow in the rear part to become turbulent. As a result, the skin-frictional drag over the rear part of the model is greatly increased. The relative areas exposed to the two types of flow can be determined from an exploration conducted near the surface of the model with a hot-wire anemometer arranged in the usual manner in a Wheatstone bridge circuit. The principle involved will be readily understood from the following considerations. If the heated wire is exposed to steady flow

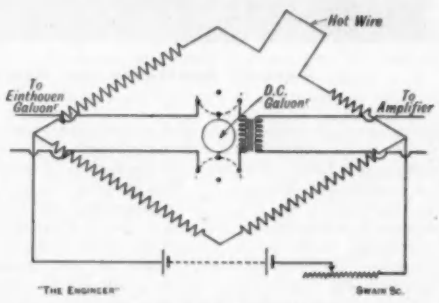


FIG. 22—CONNECTIONS FOR APPARATUS FOR DETECTING TURBULENCE—N.P.L.

it is cooled to a steady temperature, so that once the bridge is balanced by a suitable adjustment of the external current, it remains unaltered. On the other hand, turbulent flow produces an irregular cooling of the wire, and, therefore, variable out-of-balance currents. Various methods may be employed to record these, two of which are shown in Fig. 22. In the first, the D.C. galvanometer is replaced by the primary of an audio-frequency transformer, the secondary of which is coupled to a three-stage amplifier, having either a telephone or a valve voltmeter in the anode circuit of the last valve, in order that the changes of E.M.F. induced in the secondary winding of the transformer can be made audible, or be measured directly. In the other method the out-of-balance currents are photographically recorded by means of an Einthoven galvanometer and camera. From data provided by the two methods described, it was shown that the flow in the forward part of the boundary layer of an airship model tends towards a condition of laminar motion, but, at some distance from the nose, the flow becomes turbulent. At a given speed, this transition from one type of flow to the other appeared to be gradual and to take place over a short length of the model. Its position could thus only be specified within certain, though somewhat narrow, limits. The experiments conclusively showed that the transitional region moved towards the nose of the model as the wind speed was increased.

An important feature of the National Physical Laboratory exhibits was the display of apparatus for the measurement of the overall performance of radio receivers as used either for the reception of broadcasting or for more commercial purposes. The apparatus comprises a radio-frequency oscillator, the output from which can be modulated to any desired degree with the aid of a separate audio-frequency source comprising a beat tone oscillator. The modulated radio-frequency output from these generators is passed through a screened trunk to a screened resistance of special design, the current in which is measured with a non-contact vacuum thermo-junction. A tapping point is provided on this resistance so that a known radio-frequency potential difference may be applied to the input terminals of the receiver under test. The audio-frequency output from this receiver is then measured with the aid of a valve voltmeter connected across a small resistance in series with the output or loud-speaker load. As set up for measurement work at the National Physical Laboratory the oscillators are contained within a metallically complete shielded cabin, while the receiver under investigation is contained in a separate room, which is screened by wire netting. These precautions are necessary to avoid errors due to stray fields from the oscillator and also from interference from external transmitting stations. A demonstration of the working of the apparatus was given at the exhibition, a reflector hot wire galvanometer being used to indicate the current operating the loud-speaker. Demonstrations

were given of the selectivity of a typical broadcasting receiver tuned to a fixed wave-length, and of the audio-frequency response characteristic of the receiver with varying modulation frequency.

Another exhibit consisted of an assembly of apparatus—see Fig. 23—for the measurement of resistance and reactance at radio-frequencies. If a circuit consisting of an inductance and a variable capacity is inductively coupled to a self-maintained oscillating circuit and is then tuned through resonance by means of a continuous increase of the variable capacity, the frequency of the self-maintained oscillator increases to a maximum value and then falls through its original value to a minimum, after which it approaches its original value again asymptotically. These changes in frequency can be observed by means of telephones connected to a second oscillator of constant frequency, which is arranged to give a heterodyne beat with the first. From a knowledge of the frequency and the capacities corresponding to the maximum and minimum frequency changes, the resistance and the reactance of the coil can be calculated. The method is based on a modification of this principle, which permits the radio-frequency to be maintained constant throughout the measurement. The method can be applied to the measurement of unknown impedances—for example, the input impedance of valves and the impedance of aerials by associating these impedances in some suitable manner with a coil and measuring the apparent change in the constants of the coil. Measurements of the resistances and coils have been made with this apparatus at frequencies up to about 10 million cycles per second, but, with a few additional precautions, the method could probably be used with accuracy at still higher frequencies.

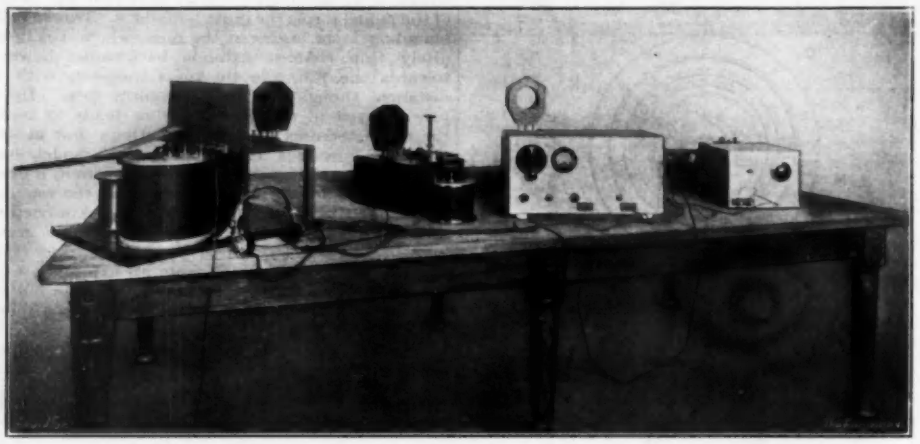


FIG. 23—RESISTANCE AND REACTANCE MEASURING APPARATUS—N.P.L.

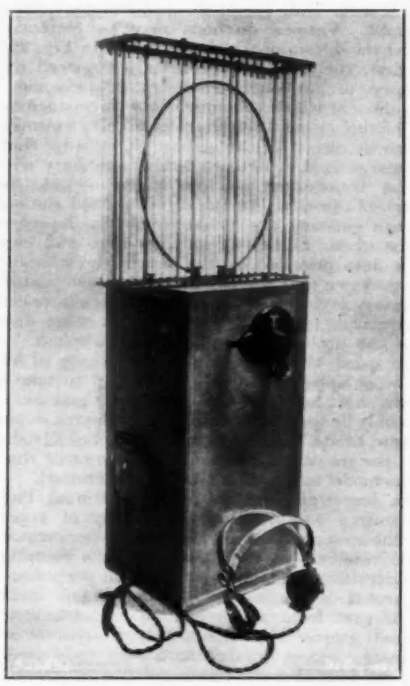


FIG. 24—WIRELESS RECEIVER AND DIRECTION FINDER—N.P.L.

Another feature of the exhibits of the Wireless Division of the National Physical Laboratory was a display of some experimental transmitting and receiving apparatus for use on wave-lengths below 10 m. (frequencies above 30 million cycles per second), and a small laboratory type of short-wave oscillator consisting of two short path receiving valves mounted in one of the familiar "push-pull" circuit arrangements. The copper wire loops forming the inductances were less than 2in. in diameter, and no tuning condensers were employed, the self-capacity of the valve electrodes being sufficient to determine the oscillator frequency, which was 200 million cycles per second (wave-length 1·5 m.). This oscillator was shown in operation, the output current being demonstrated by means of a small vacuum junction and milli-voltmeter connected to a small loop of wire coupled to the oscillating circuit.

Next to this exhibit was a transmitter employing two 500-watt valves capable of operating over the wave-length range of 5 m. to 10 m. In this case a "push-pull" arrangement employing a single tuned circuit connected between the anodes of the valves was used. The valves were mounted on opposite sides of a common panel of American whitewood in order to ensure the shortest possible leads from one valve to the other. Both the tuning condenser and the retroaction coupling condenser are variable over a small range, and interchangeable loops are employed to vary the wave-length range of the transmitter. A transmitter of this type has been in constant use for the past year in connection with the study of the propagation of these ultra-short waves along the earth's surface. To assist in this work a portable receiver has been developed, and one form suitable for a wave-length range of from 4 m. to 10 m. was exhibited. The receiver, which is shown in Fig. 24, employs a single-turn loop, which forms the main inductance of an oscillating detector valve. This stage is coupled to a single audio-frequency amplifying stage, and both of these with the necessary batteries are entirely enclosed in a screened box which forms a support for the receiving loop. With single-turn loops of various diameters up to 12in., the wave-length range covered by this receiver is from 4 m. to 10 m. By surrounding the loop with an open wire vertical screen, as shown, and by mounting the receiver on a suitable turn-table, the apparatus forms a useful radio direction-finder for the above range of wave-lengths and is capable of giving bearings to an accuracy of 2 deg., or 3 deg., at ranges up to 20 miles from a low-power transmitter.

An apparatus utilising photo-electric cells to measure luminous output and colour temperature of incandescent electric lamps was exhibited by the Research Laboratories of the General Electric Company. The apparatus—see Fig. 25—consists of a spherical photometric integrator, in which the lamp under test is operated, and two subsidiary integrators containing photo-electric cells. Micrometer shutters control the amount of light entering the small integrators and falling on the photo-cells, which are of the KV 6 plain sensitised potassium (blue sensitive) and KMV 6 potassium on copper oxide (red sensitive) types. By means of a convenient switching device the photo-cells can be operated: (*a*) In parallel for measuring lumens. In this case the shutters between the main and subsidiary integrators can be adjusted so that the combined photo-electric current from the two cells is directly proportional to the lumens of the test lamp over a range of temperature 2400 deg. to 2700 deg. K. The photo-electric current is measured on a valve bridge amplifier, and a galvanometer is balanced by adjusting a potentiometer, which is calibrated to read directly in lumens. (*b*) In a Wheatstone bridge, so that the ratio of the photo-cell currents (blue and red sentitive) is a measure of the colour temperature of the lamp under test. In this case the valve bridge amplifier is used to obtain the shutter position at which the photo-electric currents from the two cells is equal for any lamp under test. The movements of the shutter in this case are directly proportional to the colour temperature of the test lamps, and can therefore be calibrated in temperature. Among other exhibits of the Research Laboratories of the General Electric Company was a sound-measuring equipment covering a frequency range of 50 to to 5000 cycles and other apparatus used in electro-acoustical measurements. There was also a model of the plant used at the laboratories for testing the towers of transmission lines and an example of the hydraulic dynamometers specially designed for the purpose of these tests.

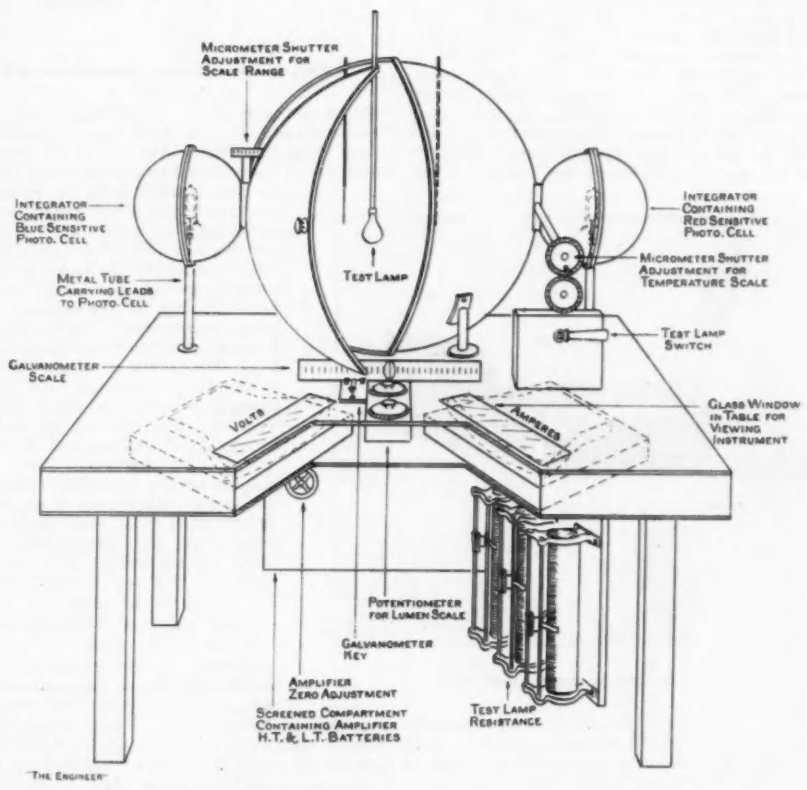

MICROMETER SHUTTER ADJUSTMENT FOR SCALE RANGE
INTEGRATOR CONTAINING BLUE SENSITIVE PHOTO. CELL
INTEGRATOR CONTAINING RED SENSITIVE PHOTO. CELL
METAL TUBE CARRYING LEADS TO PHOTO. CELL
TEST LAMP
MICROMETER SHUTTER ADJUSTMENT FOR TEMPERATURE SCALE
TEST LAMP SWITCH
GALVANOMETER SCALE
GLASS WINDOW IN TABLE FOR VIEWING INSTRUMENT
VOLTS
AMPERES
POTENTIOMETER FOR LUMEN SCALE
GALVANOMETER KEY
AMPLIFIER ZERO ADJUSTMENT
SCREENED COMPARTMENT CONTAINING AMPLIFIER H.T. & L.T. BATTERIES
TEST LAMP RESISTANCE
"THE ENGINEER"

FIG. 25—LUMINOUS OUTPUT AND COLOUR TEMPERATURE MEASURING APPARATUS—G.E.C.

FLIGHT CADETSHIPS.—The Air Ministry announces that Aircraft Apprentices S. W. Needham and E. F. Porter, from No. 1 School of Technical Training (Apprentices), Halton, and Aircraft Apprentices R. Monks and A. Pyke, from the Electrical and Wireless School, Cranwell, have been selected for cadetships at the R.A.F. College, Cranwell, on the result of the examinations held on completion of their three years' training as aircraft apprentices. "Sir Charles Wakefield" scholarships, valued at £75 each, have been awarded to Flight-Cadet D. V. Johnson on the result of the recent competitive examination for entry into the R.A.F. College and to Flight-Cadet S. W. Needham. The "Hyde-Thomson Memorial Prize," valued at about £33," has been awarded to Flight-Cadet R. Monks.

The World Engineering Congress in Japan.

(By Our Special Representative.)

No. VII.*

TOKIO, December 11th.

TOKIO BANK BUILDINGS.

Since 1923, that devastating year in Tokio history, from which the city's new life is now dated, the great banks have, one after another, reconstructed their headquarters, and are being housed in buildings the equal of anything in the Western World. A curious phenomenon is this change from the impermanent building of wood, as becomes a Buddhist land, to steel and stone, but it is in accord with the truly marvellous transformation that has taken place in Tokio life within a decade.

Changes are being effected in the Bank of Japan, a typically English structure, that is now overshadowed by the newly opened branch of the Yokohama Specie Bank and by the headquarters of the great Mitsui Corporation, both of which are on the other side of the narrow streets at the flank and rear of the National Bank. The formal opening of the new Mitsui building a few weeks ago was an event, for this structure is the last word in palatial office building, and was erected and equipped regardless of cost, though, as likely as not, it will be old-fashioned and out-of-date a decade hence in this empire of eighty millions of industrious and extremely emulative people.

The new building occupies the site of the former headquarters which survived the earthquake but were engulfed in the terrible fire which swept the city and completely destroyed the central areas, the gaunt ruins of this old commercial quarter remaining for months a fearful spectacle of desolation. The former headquarters took six years in the building, 1896–1902, and were a handsome pile four storeys high with a quadrangle or bay in front. This indentation enabled traffic, particularly motor traffic, to park without obstructing the street traffic, but this advantage has gone, the new building occupying the whole site, with busy narrow streets on three sides. A traffic problem of serious proportions already exists, traffic blocks now being the rule, for on every side are great buildings, with tens of thousands of occupants, and no thought has been given as to the comings and goings of the people, the street traffic, increased hundreds per centum by the huge buildings, which attract the prosperous classes, daily creating an extraordinary jamb of motor cars in a narrow and confined area. Right in the midst of this financial quarter is the largest department store in the Empire, with its fleets of motor omnibuses and delivery wagons—itself an attraction to all visitors from the provinces. The readjustment of building sites and streets presented the great opportunity for the re-shaping of this area and providing space for moving traffic which can only increase, but the opportunity has been allowed to pass.

The new Mitsui headquarters occupy a site roughly 360ft. by 150ft., on which has been erected a steel-framed, granite-faced building of five storeys, with basement and sub-basement. The foundations consist of steel piles driven into the earth, in this neighbourhood hard and solid, on which is a layer of concrete 4ft. thick. All first-class building now in progress must be earthquake-proof, which is interpreted to mean that the foundations must be of the strongest, necessitating immense excavation and filling in work, before the superstructure is begun, taking months in the accomplishment. Another example of the topsyturviness of modern conditions, for in the old days it was the roof that demanded all the attention, which by its weight preserved the building in times of earthquake, there being no foundations, other than the stones on which the supporting pillars were placed.

American architects—Trowbridge and Livingstone, New York—secured the contract for the building, and worked in consultation with Dr. Riki Sano and other Japanese authorities. Many foreigners were engaged in the work of erection, engineers, overseers and expert mechanics. The chief materials of construction, stone and steel, were selected after careful examination; in the case of the first, visits were paid to the granite quarries of Chugoku and Inada, and the latter quarry was selected, consideration being given to the question of freight and transportation. The quantity used amounted to 117,000 cubic feet.

The steel frame seems to have attracted world-wide attention, according to the article from which we quote, bids being received from England, France, Germany, and the United States. After careful study, it was decided to place the contract with the Imperial Steel Works, which, however, had to install special equipment to make wider widths than are commonly used in Japan. At the time there was a great demand upon the capacity of the Yawata Works, which could not fill the order completely, and consequently a quarter of the total required was imported —U.S. Steel Corporation.

Underground, in the lowest basement, is the ventilation, cooling and heating apparatus—an ammonium compressor, ducts for ventilation through which the air in the upper floors is kept clean, and exhaust fans. An adhesive filter for absorbing dust is another feature of a model building. The cooling system is worked by two processes: first, by water from a well 270ft. deep, from which a pump draws about 20,000 gallons per hour. The water is stored in two tanks in the basement, of a total capacity of 36,000 gallons, and is used both for heating and cooling purposes. The second system is the ammonium compressor with brine circulating pipes, the cooling surface being about 24,500 square feet. The heating is provided by radiators, equipped with automatic regulators, ensuring a uniform temperature. The equipment heats 3000 gallons of water per hour and circulates it through the building.

Drainage against the heavy rains of the wet season, in addition to the usual exterior fittings, is provided in the sub-basement, where a sump pit receives the overflow, which is transferred by an automatic motor pump into the newly constructed city sewers.

The fire equipment consists of forty hydrants, seven in each basement, four on each floor, and two on the roof. A tank on the roof is the source of water supply. Two centrifugal pumps and a gasoline pump, each 75 H.P with a pressure of 50 lb. per square inch, are capable of pumping 500 gallons per minute to a height of 150ft.—Worthington pumps.

All the machinery in the building has its duplicate; all pumps, generators, motors being in pairs, with two spares.

The chief engineer on the work was Mr. James Stewart, of New York, who employed a foreign staff numbering thirty-eight.

INDUSTRIAL TOURS IN JAPAN.

THE day after the World Engineering Congress was officially closed the delegates broke up into parties and set out on prearranged excursions to places of industrial, historic, and scenic interest. The main body of these groups, consisting of some two hundred and fifty delegates, including also delegates of the World Power Conference, went straight to Osaka, where they had a full civic reception, and were royally entertained. They were received by committees representing the Governor of the Prefecture and the Mayor of the city. The party was divided up into eleven groups, each visiting a different factory, and incidentally making tours of the city, which, in point of population, is now foremost in the Empire, considerably exceeding that of the capital since the earthquake by reason of the expansion of the municipal boundaries, while hundreds of thousands of former Tokio people are now resident in suburbs beyond the city limits.

OSAKA.

The Imperial Mint claimed chief attention among the factories and the famous Castle among the "sights." To the British people the Mint is interesting as being the first of several institutions the British have organised in the Japanese Empire. The building, in the first place, was designed by an English architect, Mr. T. J. Waters, who designed the British Legation and other buildings, and the work of construction was begun in 1868. The Mint was organised by Major T. W. Kinder, formerly of the Hong Kong Mint, who was aided by a staff of twelve European officials. Work was started with machinery purchased from the Hong Kong Government after the Mint in that colony was closed.

The foregoing information is taken from Murray's Guide, second edition (1884). No reference is made to the beginnings of the Mint in the W.E.C. Guide, prepared for the occasion, beyond the statement that the Japanese Government purchased the machinery of the Hong Kong Mint when the latter was closed, and that "some foreign engineers were employed for the supervision of the work." It appears that foreigners were engaged at the Mint for over a quarter of a century, for it was not until 1889 that the whole work was taken over by the Japanese. One statement made in the W.E.C. Guide is of interest as showing how Japan has gradually allowed herself to be deprived of what should be her greatest asset—the artistic skill of the people, which is so generally diffused that articles of commonest domestic use immediately attract the attention of foreign visitors because of their dainty, artistic shapes. Says the Guide:—"Brief mention may, however, be made of the fact that, even at the time when the entire work was done under the guidance of foreign engineers, the art of engraving were (*sic*) done by the dextrous hands of Japanese artisans. But change of circumstances and the lack of skilled artisans in this modern age necessitated the adoption of machines for this line of work."

The Mint is in some sense a misleading name, for it is a great and profitable industry. In 1884, according to Murray, it gave employment to 600 persons; to-day its site covers 25 acres (28,000 tsubo), and there are besides the main works, 108 dwellings for officials and 200 for skilled workmen. The total number of workers is not given. The yearly productive capacity is some four hundred million coins, in all metals, and in addition the following subsidiary business is carried on:—Refining of gold and silver and certification of quality; manufacture of alloys; assay of minerals; manufacture of medals and stamps. The Mint has also organised a metal assay conference composed of mine owners and others which endeavours to unify the method of assay.

The famous castle of Hideyoshi would "intrigue" the engineers—the donjon, or keep, and the massive stones of the outer walls, 40ft. long, 10ft. high, and unknown feet in thickness. Over three hundred years ago these were transported from distant parts of the country by tens of thousands of "labourers," practically slaves, and the castle was conceived and completed within the space of two years, work going on night and day. How the castle impressed contemporary foreigners appears from the writings of Will Adams, the Kentish pilot, the first Englishman to live in Japan. Adams says:—"I was carried in one of the King's gallies to the court at Osaca, where the King lay about eightie leagues from the place where the shippe was. The twelfth of May 1600, I came to the great King's citie who caused me to be brought into the court, beeing a wonderful costly house guilded with gold in abundance." Captain John Saris, commander of an English ship, who has left a diary of his journey overland, says of the city and the castle:—"We found Osaca to be a very great towne, as great as London within the walls, with many faire timber bridges of a great height, seruing to pass ouer a river there as wide as the Thames at London. . . . It is one of the chiefe sea-ports of all Jipan: hauing a castle in it, marvellous large and strong with very deepe trenches about it, and many drawbridges, with gates plated with yron. The castle is built all of free stone, with bulwark and battlement with loope holes for smal shot and arrowes, and diuers passages for to cast stones upon the assaylants. The walls are at least sixe or seuen yardes thick all (as I said) of free stone, without any filling in the inward part with trumpery, as they reported unto me: the stones are great, of an excellent quarry, and are cut so exactly to fit the place where they are laid, that no morter is used, but onely earth cast betweene to fill up voyd creuises if any be."

The walls remain exactly as Saris describes them: a puzzle to all beholders, quite as puzzling as the huge stones of Baalbek, or the much smaller stones of the Pyramids. Would Labour do such work to-day?

The castle is the headquarters of a military division.

Osaka, like Tokio, is ambitious of being a great sea-port, though each has within 20 miles great ports that have natural harbours, Kobe and Yokohama respectively. Osaka has spent many millions in providing itself with a harbour for large sea-going vessels; Tokio is doing the same. The great liners of the Nippon Yusen Kaisha are registered as of Tokio, which is thus their home port, though if these gallant ships ventured far up the fairway to Tokio Bay they would find themselves on the mud bottom. The approaches to Osaka, however, are more favourable. The new harbour is enclosed by a breakwater, and from the land running towards the centre of the harbour is a handsome pier, capable of berthing a succession of ocean liners. It was built in 1903, but under modern conditions is not so good as it looks. The authorities have decided to reduce its length, 1500ft., by half, the quay accommodation being preferred by the big liners, and, moreover, the reduction will give more room within the breakwater for manœuvring vessels of large tonnage.

The best news the citizens of Osaka have had for long, to which they have looked forward for many years as a means of recouping themselves for an enormous outlay, is the decision of the two great Japanese companies, the Nippon Yusen Kaisha and the Osaka Shosen Kaisha, to make Osaka a port of call for the European and American liners. By the spring the harbour will be continuously occupied by one or other of the two companies' ships, which now have lines linking Japan with every great port in the world. The change will mean much to Osaka, and to some extent it must adversely affect Kobe. It is not improbable that the change will influence foreign companies to follow the Japanese example, for Osaka is the entrepôt of the national trade. And what effect this development will have upon Tokio remains to be seen. Harbour construction in both cities involved a heavy increase of debt, and for years the harbour at Osaka was regarded as a white elephant. In the case of Tokio, the city at this moment is unable to meet its financial obligations to the Government, in consequence of the disastrous experience of 1923; but the final triumph of the western port may well arouse the spirit of emulation in the capital, to the prejudice of Yokohama—though Tokio has to dredge a 15-mile fairway before it can accommodate large ocean-going ships.

The delegates had an opportunity during their short stay to visit other civic enterprises and the mills and factories of leading companies, the Railway Rolling Stock Manufacturing Company, Sumitomo Steel Mill, Sumitomo Electric Wire Works, Shimada Glass Factory, Oriental Spinning Mill, Osaka Dyeing Factory, Nippon Paint Works, Seihan Printing Works, and hosiery and other factories, the products of which are well known on the English market, and are being increasingly exported to India and Africa, where Japan maintains commercial "museums," which apparently are regarded as successful commercial agencies.

KYUSHU INDUSTRY.

After Osaka, probably the most important industrial centre lies among the coalfields of Kyushu. The guide pamphlet dealing with the towns of this area, the Government Steel Works, and the coalfields,

* No. VI. appeared January 10th.

prepared those delegates not particularly informed to appreciate the truly remarkable developments that have taken place in this region during the past twenty years. The great steel works, in which the Government has invested during the past thirty years Yen 130,000,000, are one more example of ultimate success only possible where subsidy is the rule and hungry shareholders have not to be considered. It may be said with confidence that nine-tenths of Japanese industry would not exist if the Government had not been behind it at one time or another. For years after their foundation the steel works were the butt of criticism and ridicule, but to-day they are working at capacity and must continue to expand in this industrial nation.

The steel works were established on the model of Krupps—*vide* Murray's Guide—and after years of loss, disappointments and persistence they are assuming a size and shape that make comparison with the Krupps of a past day not entirely ludicrous. But still they are modest in proportion. The works to-day, according to the pamphlet referred to, employ about 20,000 men and produce nearly 900,000 metric tons of steel a year—soon to be a million tons, as forecasted by one of the papers presented to the Congress. What proportion of this output is consumed by the naval and military services is not stated, but there is increasing demand from industry in general, and the catastrophe in the Tokio and Yokohama areas has had not a little to do with the present prosperity of the works. What proportion of the finest quality steel is supplied to the Navy, for example, is also a problem. During a recent session of the Diet a Navy Department spokesman angered patriots not a little by the assertion that the Navy had to have the very best steel regardless of place of production, and could not yet place full reliance upon the products of the Imperial Steel Works. Indignant members had visions of incomparable blades produced by sword-smiths in the Middle Ages, which probably have no equal in the world, and did not stop to think of the difference between simple handicraftmanship and the highly technical processes used in steel making to-day; the right qualities of coal and iron ore, so difficult to obtain, and the limited mechanical means at the disposal of Japan. But Japan has no doubt well learned the lesson. The Navy must have the best steel, and Japan will produce it. Perhaps, however, the time is not far distant when the Navy will no longer require steel and the country will be using a better quality of ploughshare.

The great factor in the development of Japan, after war, was the railway. War has been the prime stimulator in the creation of every large enterprise. The charter rates Japan had to pay during the war with China, 1894–5, determined the Government to enter upon a programme of shipbuilding and aid the infant shipping industry by subsidies which have ever since been continued. Without official aid, Japanese shipping could not exist. In regard to shipping, at least, the nation is not yet able to compete in the open market with other nations, or so it appears.

Before the railway came to Kyushu the island was as it had been five hundred years before. The coal was there, and for hundreds of years had been used in a small way, but until the opening of the first railway in 1889 there was no commercial development. To-day North Kyushu is Japan's Black Country; its historic places and scenic beauties are marred by ugliness—and the people rejoice. The Japanese love to be mistaken for a great industrial nation, and hate to be reminded of their artistic instincts—their blows with the hammer are the blows of a child; their touch with the pencil the touch of the artist. Development on an industrial scale began, and before many years were passed travellers on ships anchored in the Shimonoseki Straits noted with curiosity the novel method of coaling pursued, myriads of little women, many with babies on their backs, standing on an inclined plane in long rows and for hours on end passing upwards tiny baskets each holding a few pounds of the black diamond until the bunkers were full; the operation maintained to a sort of ship's shanty, led by the men in the belly of the great junk filled with coal. The passengers, however, did not go into the bowels of the earth to see the workers there—and perhaps as well. Conditions are changing: human slavery of this sort is becoming a matter of history. The Japanese are behind no nation in a mental alertness that prompts a quick change when change becomes necessary, and they have model mines as they have model factories.

(To be continued.)

TRANSPORTATION difficulties of unusual severity, requiring the moving of 122 tons of material down 7½ miles of steep, zigzag pack trail, dictated the design and method of construction used for the new Kaibab Trail suspension bridge across the Colorado River in Grand Canyon National Park, which is described in the *Engineering News-Record*. The new bridge replaces an old structure where the trail crosses the river just above the mouth of Bright Angel Creek. At this point the canyon is more than a mile deep and about 8 miles wide at the top. The new bridge is 500ft. long between supports with a 440ft. stiffening truss designed with members less than 10ft. long and weighing less than 200 lb., necessitated by the pack-trail transportation.

The Failure of a Rock Fill Dam in Victoria.

A RESERVOIR was recently formed by the State Rivers and Water Supply Commission of Victoria by the construction of a dam known as the Eildon (Sugarloaf) Weir across the river Goulburn. As at first designed, the dam was intended to impound water to a depth of 130ft., so as to create a reservoir with a capacity of some 300,000 acre-feet, with the idea that it might be at some future time raised 40ft. so as to impound water to a depth of 170ft. and form a reservoir of 720,000 acre-feet capacity. The reservoir was filled to its full capacity on August 21st, 1927, for the first time, and on October 6th, 1928, stood safely with 4·2ft. of water flowing over the spillway. For a year and eight months after the first filling the structure appeared to be carrying out its function satisfactorily. The level of the water fluctuated with the changes in demand and supply, but the reservoir remained moderately full all the time. For the four months preceding October, 1928, the water stood at approximately full-supply level, and then during the summer months it began gradually to fall, until, on April 26th, 1929, it stood at R.L. 776ft., the R.L. of the spillway crest being 823ft. On that date a subsidence of the bank on the upstream side of the core wall occurred between chainages 850ft. and 2050ft., exposing the core wall to a maximum depth of 26ft.

Within a month of the occurrence, namely, on May 24th last, the Governor of the State in Council appointed the following Board of Engineers to investigate the matter :—

R. W. Chapman, C.M.G., B.C.E., M.I.E. Aust., Professor of Engineering, University of Adelaide (Chairman);

H. H. Dare, M. Inst. C.E., M.I.E. Aust., Commissioner, Water Conservation and Irrigation Commission, New South Wales;

E. G. Ritchie, M. Inst. C.E., M.I.E. Aust.

The terms of reference were to inquire into and report as to—

(1) The cause of the recent subsidence of the Eildon (Sugarloaf) Weir;

(2) Whether there are any structural defects in any portion of the works constituting the said Weir;

(3) Whether the whole structure is efficient for the purpose for which it was designed;

(4) The appropriate means of remedying such subsidence or defects (if any) and increasing the safety of the said works; and

(5) Whether there are other matters connected with the construction or operation of the said works which the Board thinks that it is desirable to report upon in the interests of public safety.

The Board reported on July 9th following, or only forty-six days after it had been appointed. A copy of the report lies before us, and from it we have abstracted the particulars contained in what follows.

As will be seen from the accompanying engraving, Fig. 1, the dam is of irregular shape in plan. It consists of an embankment with a core wall having a length of 2300ft. and a mass concrete spillway having a crest length of 682ft. It was decided, when the proposal to construct the reservoir was first put forward officially in 1912, that, owing to the great length of the dam, it would be financially impracticable to construct a barrage of solid masonry of the type generally accepted as standard for such work. The modification considered feasible by the State Rivers and Water Supply Commission was a rock-fill dam with a cellular core wall of concrete, and, in addition, "a clay core wall of substantial dimension." Apparently, the rock-fill type of dam was chosen because good rock quarries could be easily opened out quite near to each end of the dam, and because there was plenty of clay available close to the site. The design finally adopted is shown in Fig. 1, which is reproduced from the Board's Report. The embankment dam was built with three straight sections joined by two curves. A diaphragm wall of reinforced concrete extends right along the centre of the dam from crest level down to solid rock, which, in the deepest place, is 75ft. below ground surface. This core wall is 1ft. 11in. wide at the top and increases to a thickness of 5ft. or 6ft. at the bottom, depending on the height. Its foundations were carried about 5ft. down into the solid rock to make a water-tight connection. It is reinforced on both faces by a grid of ½in. steel rods placed horizontally and vertically at 12in. centres, 3in. from the surface.

On the upstream side of this core wall was built a wall of clay about 30ft. wide at the bottom and about 20ft. wide at the top, the dimensions varying some-

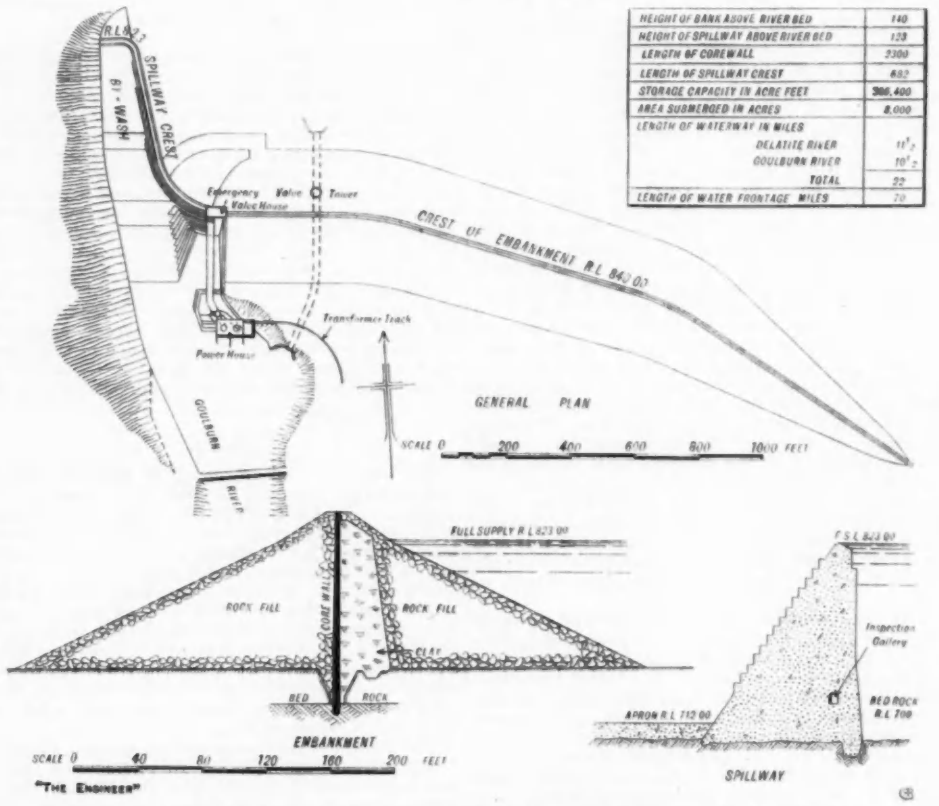


FIG. 1—PLAN AND SECTIONS OF EILDON (SUGARLOAF) WEIR AS ORIGINALLY DESIGNED

what with the height. This clay wall had its maximum thickness at ground level, and it was extended to bed rock over about 900ft. length of the dam. Over the remainder of the length, where the foundations are deeper, the clay wall was founded on and keyed into clay below the natural surface. In height, it originally reached to within about 5ft. of the top of the concrete core wall.

On both faces the dam was completed by masses of rock fill, consisting of all the material, both fine and coarse, that was broken down in the quarry. This rock fill was obtained from quarries conveniently situated near each end of the dam, the excavation for one of them forming the spillway on the Sugarloaf side. Approximately equal quantities of stone were placed in the bank from these quarries, but, according to the Report, the stone from the quarry on the Sugarloaf side was, on the whole, markedly superior to that from Pinniger at the other end. As designed, the top width of the dam was 16ft., but actually it was built much wider at the top to facilitate the future raising of the embankment. The rock fill was designed to be trimmed to slopes of 2 to 1 on each side. "The work of trimming the slopes to a 2 to 1 batter has not," says the Report, "yet been done, and in places the slopes are standing at angles considerably steeper than 2 to 1, with horizontal berms at intervals. The object of leaving the slopes in this unfinished condition was to facilitate the junctioning of further masses of rock fill in the event of the dam being raised at some future date."

A concrete spillway of the side spillway type with a weir wall 682ft. long was built at the Sugarloaf end, the level of the crest being R.L. 823ft. As the R.L.

at the top of the dam is 840ft., there is a freeboard of 17ft., which means that water would be pouring over the spillway to a depth of 17ft. before it could overtop the core wall of the dam. The spillway is not straight, for, owing to its situation, it was necessary to curve it in plan.

Near the spillway end of the dam a circular valve tower of reinforced concrete, with foundations on solid rock, rises through the upstream slope of the bank. In it are eight gates, each 5ft. 9in. by 3ft. 7in., which control the flow of water to an outlet tunnel. Four of these gates have their sill levels at R.L. 706ft. and the others at R.L. 754·75ft. These gates are all operated by means of hydraulic lifters, and slide on gun-metal runners. In addition, three other gates are placed in the wall of the spillway section, with sill level at R.L. 754·5ft., which are for admitting water to a power station below. They also are operated by power lifters and each, when raised, affords a clear waterway measuring 10ft. by 4ft.

In describing the failure, the Board states in its Report that the greatest subsidence took place alongside the core wall, and that the exposed face of concrete was heavily scored with markings caused by the sliding of the stones of the rock-fill embankment over the surface. These marks showed that, at chainage 1550, where the subsidence was greatest, the movement along the face of the wall had been vertical, whereas, on each side of that point, the markings at the top of the core wall were inclined at an angle with the vertical which increased with the horizontal distance and dipped towards the point of greatest subsidence. Then, as the marks were traced down the wall, they gradually became more vertical. With the core wall exposed, it was noted that the pressure upon it had caused considerable deflection. At two points in the wall, one at chainage 1600, approximately in the middle of a straight length of 800ft., and again at chainage 2300ft., almost in the middle of a 400ft. length of straight, the deflection at the top of the wall amounted to no less than 4ft. 8in. in a downstream direction. At the curves connecting the straight portions of the wall the movement had been very slight; it was most marked in the centres of the straight portions.

"As was to be expected," continues the Report, "such pronounced deflection from the original line of the wall did not occur without development of cracks. A considerable proportion of the vertical contraction joints, which were built at intervals of 50ft. apart, had opened out somewhat on the upstream side, and a few other vertical cracks had developed, some of which go through the wall at the top. Several inclined cracks had also become evident. . . . Although the top of the wall has been pushed downstream to the extent of 4ft. 8in. at two points, the downstream bank does not seem to be appreciably affected. Apparently, the deflection of the wall has been made possible by a consolidation under pressure of the upper portions of the rock fill, and the surveys do not show movements of any consequence at either the toe or the top of the downstream bank. In addition to the cracks already noted, a very serious crack was exposed by the removal of material covering the top of the concrete core wall at chainage 2434ft., where the core wall joins on to the thickened section adjacent to the spillway. At this point the crack as disclosed extended right through the wall and showed an opening of about 1in. on the upstream face at the top. At this point there had been very little subsidence in the rock fill."

The Report then goes on to state that, so far as the observations of the Board extended, not only the concrete, but the stone for the rock fill from the quarry on the Sugarloaf side were first class. The rock from the Pinniger Quarry, on the other hand, is described as being "not so good," but the Board states that it saw no evidence that it was not sufficiently good for the purpose, or that its deterioration under water was in any way the cause of the collapse. The clay was obtained from borrow pits both up and downstream from the dam, conveniently situated near the site, and appeared to be of good quality for the purpose.

Discussing the clay wall, the Report proceeds as follows:—"An unusually thick wall of clay was built, but this was done because it was intended to raise the height of the dam at some future time. Unfortunately, the behaviour of clay in large masses is a subject upon which engineering knowledge at present is by no means profound. No material has been more extensively used in dam construction, and its value has been demonstrated by long experience. Yet there are no standardized tests to which it may be subjected, and the engineer has to rely largely upon his practical experience and judgment. The clay appeared to be suitable for the work, it stood up to the ordinary 'sausage' test, and it made a stiff uniform pug, when kneaded with a small quantity of water, that seemed quite good. Unfortunately, when subjected to the continued action of water, it appears to have become very plastic. It is easy, of course, to be wise after the event, and it is this particular feature in the behaviour of the clay used for the wall that seems to have been responsible for most of the troubles that have arisen."

The Board then describes what happened to the embankment as disclosed in the course of the investigations which it caused to be carried out. Our readers will be assisted in understanding the explanation given by comparing Figs. 2 and 3, the first of which shows a typical cross section of the embankment as it was actually constructed, while Fig. 3 is a section of the embankment where subsidence had taken place as revealed by borings which the Board ordered to be made. The Report explains that, on the upstream side, not only did the bank sink at the top, but the face of the bank had also been pushed horizontally upstream, with very little alteration of shape, right down to the toe, which in some places was, when the Board examined it, as much as 55ft. further out than in the section as built. "This movement at the toe," states the Report, "is not apparently due to rock sliding down the slope, but has been caused by a tremendous horizontal force that has pushed the bank bodily forward, the sliding having taken place low down in the bank, and probably in the vicinity of natural surface. This can only have been done by the exercise of a force much greater than that due to ordinary water pressure. The ground level beyond the toe of the bank appears to have remained unaltered. Soundings under water do not disclose that there has been any 'spewing up' or upheaval of the ground such as would have been caused had there been any collapse due to the squeezing out of the clay below ground surface under the weight of the bank. Between the level of the natural surface on which the rock-fill bank rests and the solid rock below, there is a varying depth of some 20ft. of soil, clay and gravel. It is conceivable that the clay below natural surface level may have become plastic through saturation with water, and may have been pressed out sideways under the great weight of the bank, causing a collapse of the surface. But if this had happened there must have been lifting of the natural surface beyond the toe of the bank, and there is no evidence of this in any of the sections as surveyed."

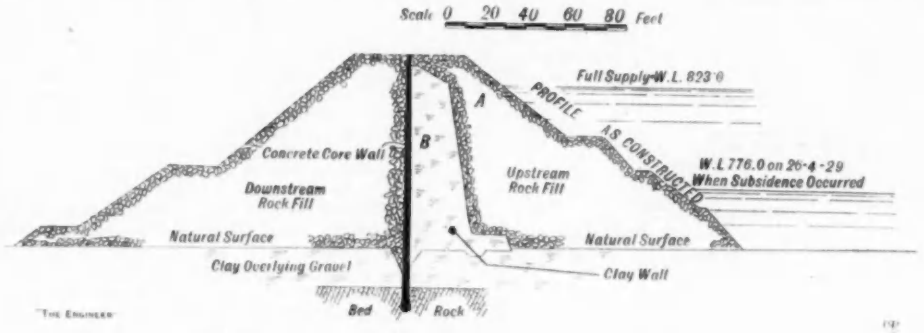


FIG. 2—SECTION OF DAM AS ACTUALLY CONSTRUCTED

The following explanation of what took place is then put forward in the Report. The Board suggests that the most probable theory on the evidence seemed to be that the great wall of clay, 90ft. high above the natural surface over the greater portion of the length of the dam, and, near the river bed, considerably higher, had become more plastic as the result of continued contact with water. The rock fill bank, which supports it on one side, contains, it is pointed out, a large percentage of voids, and the water permeates it freely. "If," goes on the Report, "the clay in the wall is of such a character that under the influence of water it behaves somewhat as a thick heavy viscous mass, it might set up enormous pressures both against the concrete wall on the one side and against the upstream rock fill on the other. This might account for the large deflection of the core wall, and for the movement of the bank. Whilst the reservoir was full, this pressure was balanced on the upstream side by the pressure of the water supplemented by the weight of the immersed rock fill. When the water pressure against it was partly withdrawn by the lowering of the surface level in the reservoir, the weight of the rock fill was no longer sufficient to hold the clay wall in position, and a displacement with consequent subsidence of the rock fill took place."

It was in order to test this theory that it was arranged to put down a series of bores across a section of the dam on the upstream side of the core wall, so as to examine the condition of the clay and to determine exactly what had happened to the clay wall. A series of bores drilled at different points across the upstream side of the embankment at chainage 1550ft., where the greatest subsidence occurred, disclosed that, whereas at that point the initial subsidence at the top of the rock fill was 26ft., the top of the clay wall had sunk no less than 51ft. Moreover, as the clay wall collapsed, it flattened out, so that at 45ft. from the core wall the depth of clay penetrated by the bore before reaching ground surface level was 34ft., and at 75ft. from the wall the depth was 20ft. "An astonishing feature," remarks the Board, "is that once the drill penetrated the clay at this section it encountered no more rock. So that it was not a case of the clay forcing itself into the interstices of the rock fill, but apparently the pressure exercised by the clay was so great that it actually forced the rock outward, and at this point the toe of the bank is pushed out 55ft. The same force that produced this surprising effect upon the rock fill must have been exerted by the clay in the opposite direction on the concrete wall, and it speaks well for the material and construction of this wall that it has not suffered greater damage than has actually been the case. Subsequent borings at section 2350, where the amount of subsidence of the upstream bank was small, showed that the clay wall had also sunk here to a much smaller extent. The borings disclose the fact that the clay wall has subsided to a much greater degree than the bank as a whole, and leave little doubt that the movement of the upstream bank and the deflection of the concrete wall have been caused by the excessive pressure of the great wall of clay."

It is then explained that tests made at the Adelaide University indicate that a wall of the clay employed would, in the form of a stiff pug, exert a side pressure equivalent to a liquid weighing 70 lb. per cubic foot if 50ft. high, but if 100ft. high its pressure would be equal to that of a liquid weighing 85 lb. per cubic foot. If, however, "5 per cent. of water be now added and mixed with the clay, a wall made of it 50ft. high will exert a pressure equal to that of a liquid weighing 101 lb. per cubic foot."

These tests, the Board states, give an approximate measure of the immense forces that a high wall of this

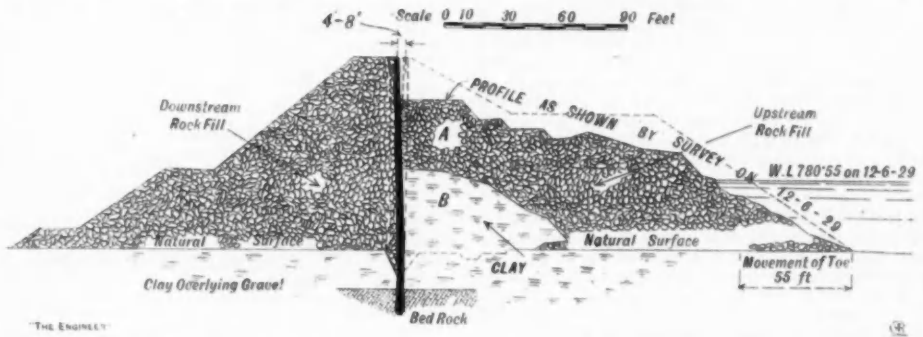


FIG. 3—SECTION OF DAM AFTER SUBSIDENCE AS INDICATED BY BORINGS

clay, particularly after being in contact with water, might exert on the rock fill supporting it on the one side, and on the concrete wall at the other side. "When the subsidence took place," it adds, "the surface of the water stood at R.L. 776·47ft. below full supply level near which it had remained during the previous winter and spring. The reduction of level withdrew the supporting pressure of the water from the clay wall after the water had been in free contact with the clay for the whole period of six months during which the reservoir level was high. The rock fill would allow the water to permeate it quite easily, so that the clay would be standing, supported by the rock, in contact with water. When, by the reduction in the level of the reservoir, the supporting power of the water was partially withdrawn, the great wall of moistened clay, about 100ft. high, was able to exert such an enormous pressure that it pushed upstream the rock fill in front of it as shown by the borings. The lower part of the rock fill at this time was wholly immersed, and consequently its weight and resisting power were correspondingly reduced. . . . Fortunately, the subsidence of the clay wall appears to have taken place over the greater part of the length of

the dam and the forces which it can exert are now appreciably reduced, except perhaps near each end, where little subsidence has yet occurred. It has probably done its worst. The clay still remains to protect the lower part of the wall against percolation, but the upper part will no longer have that advantage."

In discussing whether the whole structure is efficient for the purpose for which it was designed, the Board states that it cannot say that in its present condition it is, nor can the original design be restored. The clay wall extended at the outset to within 5ft. of the top of the concrete wall and either down to clay level, at places where the depth of the rock below ground surface was great, or down to solid rock where the rock was comparatively shallow. "This construction," it is remarked, " points to the fact that the idea of the designers was, not that reliance should be placed upon the clay for preventing the passage of water, but that the clay should be present to provide material for staunching any flow which might occur through cracks in the concrete. Owing to the sinking of the clay wall, this material is no longer present over the upper sections of the wall, and it becomes necessary to take measures to deal with such defects in the concrete wall as make their appearance. The existence of the clay wall is not an absolute essential, as many rock-fill dams have been constructed with a core wall of concrete only. In this dam the protecting influence of the clay will still be present over the lower sections of the wall to ground level, but even if such a course were possible, it would be very inadvisable after the experience of its behaviour, to rebuild the clay wall up to the top."

On the question as to what additional measures should be taken for public safety the Board recommended that the water level should, following the date of its Report, be kept, as far as practicable, somewhere in the neighbourhood of R.L. 775 until towards the end of the season, when spring freshets might be expected. It expressed the opinion, also, that the water should not be allowed to reach a higher level than, say, R.L. 800 to 808, until remedial measures were sufficiently advanced. It was further recommended that regular observations of the deflection of the core wall, gaugings of leakages, and movements, if any, of the bank, should be continued.

There is a great deal more in the Report, but we cannot spare space to discuss the various points in detail. It must suffice to say that the Board found that the subsidence had, in addition to exposing, and causing deflections and cracks in, the concrete core wall, making it to be less water-tight than it had been, (*a*) unduly strained the outlet tower, causing some cracks and a slight change of shape ; (*b*) rendered the base of the triangular mass of rock fill on the downstream side of the core wall liable to become unduly wet from leakages through the core wall, so that its ability to withstand the outward pressure of the water from the reservoir was reduced ; and (*c*) caused some danger to the upper or emergency outlet to the hydro-electric power station, because of the liability of subsidence from the embankment occasioning partial blockage. Additional defects were found in the main gates for letting water out of the reservoir by way of the outlet tower. Furthermore, the Board considers that the present spillway or overflow from the reservoir, though ample for the discharge of large floods, is of insufficient capacity safely to discharge the largest flood that might be expected.

The remedies suggested by the Board, some of which are illustrated diagrammatically in Fig. 4, were as follows :—

(1) To restore the subsidence of rock fill on the upstream side by the deposition of more loose rocky material to provide for greater weight and stability ;

(2) To provide drainage under the base of the downstream side of the embankment, including a tunnel to carry off such water as may pass through the core wall, and to add a large quantity of rock fill to this part of the embankment for the purpose of increasing its supporting power ;

(3) To repair all cracks of importance in the concrete core wall and to provide, where necessary, staunching material on the upstream side of that wall in place of the clay formerly in position for that purpose ;

(4) To stiffen the tower against the outward pressure of clay and water by placing sections of concrete inside it ;

(5) To extend the discharge pipes from the outlet tower and provide new outlet valves ;

(6) To provide an extension to the existing emergency outlet to prevent its entrance from being blocked by any possible further subsidence of the embankment ; and

(7) To provide an additional spillway at the opposite end of the embankment to that at which the present spillway is situated.

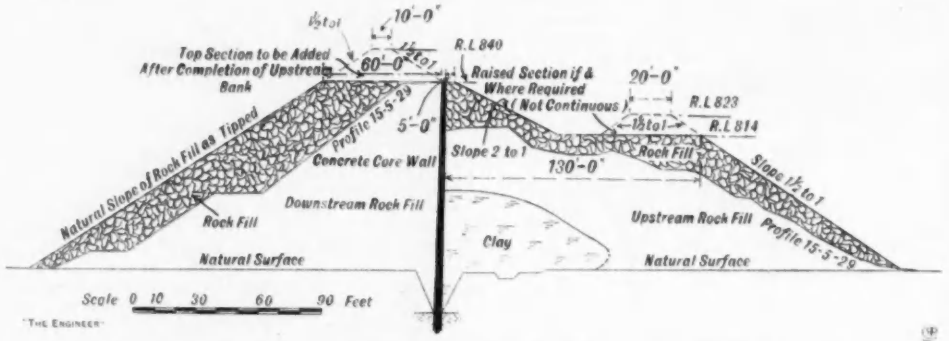


FIG. 4—DIAGRAM ILLUSTRATING SOME OF THE PROPOSED REMEDIAL WORKS

In connection with the foregoing we received the following letter from Mr. J. T. Noble Anderson, M. Inst. C.E., of Melbourne :—

SIR,—During the last few months the public has been alarmed by sensational happenings on a large rock-fill dam which was nearly completed across the Goulburn River. The matter is of sufficient interest from the unusual features of construction and the very large interests involved, for notice in your publication. This is the latest and perhaps most important addition to the series of dams which have been constructed to store water in this State, and has involved an expenditure up to date of £1,500,000. The total storage aimed at by the construction of the first stage was to have been 306,000 acre-feet. Estimates after the work had been initiated, but when the plans had only just been tentatively plotted in September, 1917, were given by the constructing authority, the State Water Commission, to the Government, for the first stage of the work, at £460,000. The cost at that time, of only a trifle over 30s. per acre-foot, was deemed satisfactory. The design of the structure is rather unusual. The evidence is that the precedent on which the responsible engineer relied was the Goose Creek Dam, Idaho, U.S.A (see *Engineering News*, 1913, I., 516). The result was that the Government decided on such a dam. The Goose Creek Dam was originally intended to be constructed by hydraulic fill methods, but owing to lack of water and for other reasons had to be converted into a rock-fill construction, but the clay core wall was retained. There is some evidence that at first the hydraulic-fill method was intended here also, as the clays at Eildon were very suitable. Unfortunately, however, in two very important particulars, the Goose Creek Dam was not copied. These were the multiple puddle trenches under the bed of the bank, and both the slopes of the bank, the outer slope being 1½ to 1 instead of 2 to 1, while the inner slope was constructed even steeper than the outer, and less than half that of the Goose Creek Dam. Whether even that would have been adequate for an 170ft. high dam, which this Australian copy was intended to be, is questionable. The most serious blunder was in the treatment of the puddle core, and from this arises the present trouble. Contrary to all established practice, this was placed directly under the rock fill, and, being excellent plastic material, naturally slumped, with the result that the rock fell inwards, and the weight gradually increased till at the time when the matter was investigated the overburden of rock on top of the plastic clay had increased from its original average of about 8ft. to more than four times this depth, and was proportionately heavier. The plastic clay in slumping naturally shoved the toe of the rock fill into the bed of the dam, and also under the same conjugate pressure the concrete diaphragm showed signs of distress.

The Government appointed a Board consisting of two prominent engineers, and the Senior Engineering Professor of Australia, to investigate and report. At the date of the report the core of puddle had slumped 43ft., and the concrete diaphragm was showing signs of distress. It will be seen that the urgency of the case has very seriously hampered this Enquiry Board, and caused it to bring in a report which from its indefinite nature has done little to quieten public panic. Since then, on two occasions, the electrically-controlled alarm bells which have been installed in the Goulburn Valley have accidentally turned the residents out from their homes to spend the night under the winter sky. The frantic efforts to double the flood discharge capacity of the spillways has naturally augmented the anxiety and dread in which these unfortunates are living. In Parliament, too, a strong effort has been made to get a closer investigation. The more so as the work done under the advice of the Board does not generally commend itself. (See the Board's new profile retaining the 1½ to 1 batters, and only increasing the berm just as far as the present toe justifies it.) This will probably be revised, as the report from the patrol of August 20th shows that the slump is still going on, though reduced to less than 2in. a day, and the further fact that residents from below the dam declare that the water is heavily coloured, presumably by dissolved clay from the puddle core. The fact seems to be established that so far this clay has not to any appreciable extent been washed away because the area of the slumped clay is apparently the same as the area of the clay in its original position. However, the investigations of the Board distinctly indicate that there is more leakage past the diaphragm than is wholesome.

From regard to all the circumstances, it seems a little strange, first, that the Board should have recommended so drastic an increase in the flood provision, seeing that there are no circumstances, such as afforestation, to increase the rate of run-off ; and second, does not recommend any further check walls to be formed in the bed of the dam ; and thirdly, should not take some step to hold up the distinctly impervious clay core, which would be invaluable if the water level is to be raised as was originally intended. The expedients which it recommended, viz., increasing the rock fill above and in front of it, tending, *prima facie*, to flatten it still further. And with each foot that it sinks the danger to the concrete core from the ordinary hydrostatic pressure of the water in the dam will become greater. However, it is obvious to me that this report can only be taken as a hurried interim report. The last word has not yet been said. It is hardly likely that the public will be content with a scheme that aims at only providing a total storage capacity of 200,000 acre-feet after a gross expenditure of close on two million pounds or ten pounds an acre-foot, and the question has been asked in Parliament, " Are there no engineers in Australia ? " Given the excellent clay and gravel which undoubtedly exists at the present site, and it should even now be feasible, and profitable to construct at this site an " hydraulic-fill " dam to give the full 600,000 acre-feet capacity originally estimated, and at less expenditure than on the methods which the Board recommends, to give only 200,000 acre-feet. I do not make this statement without full knowledge. I originally recommended this site to the then Victorian Government, and laid before it the details of the Necaxa Dam No. 2, as published by you 8/11/1907—[The cross section of the dam given in that issue is reproduced in Fig. 5.—ED. THE E.]—and was assured by Mr. Elwood Mead that this method would be adopted. Unfortunately, it would appear that Mr. Mead left Australia before the present design was finally approved.

J. T. NOBLE ANDERSON.

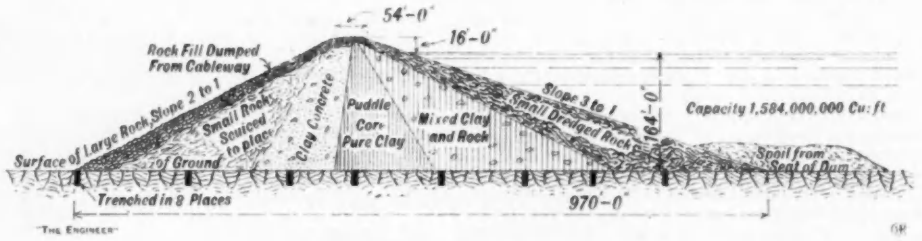
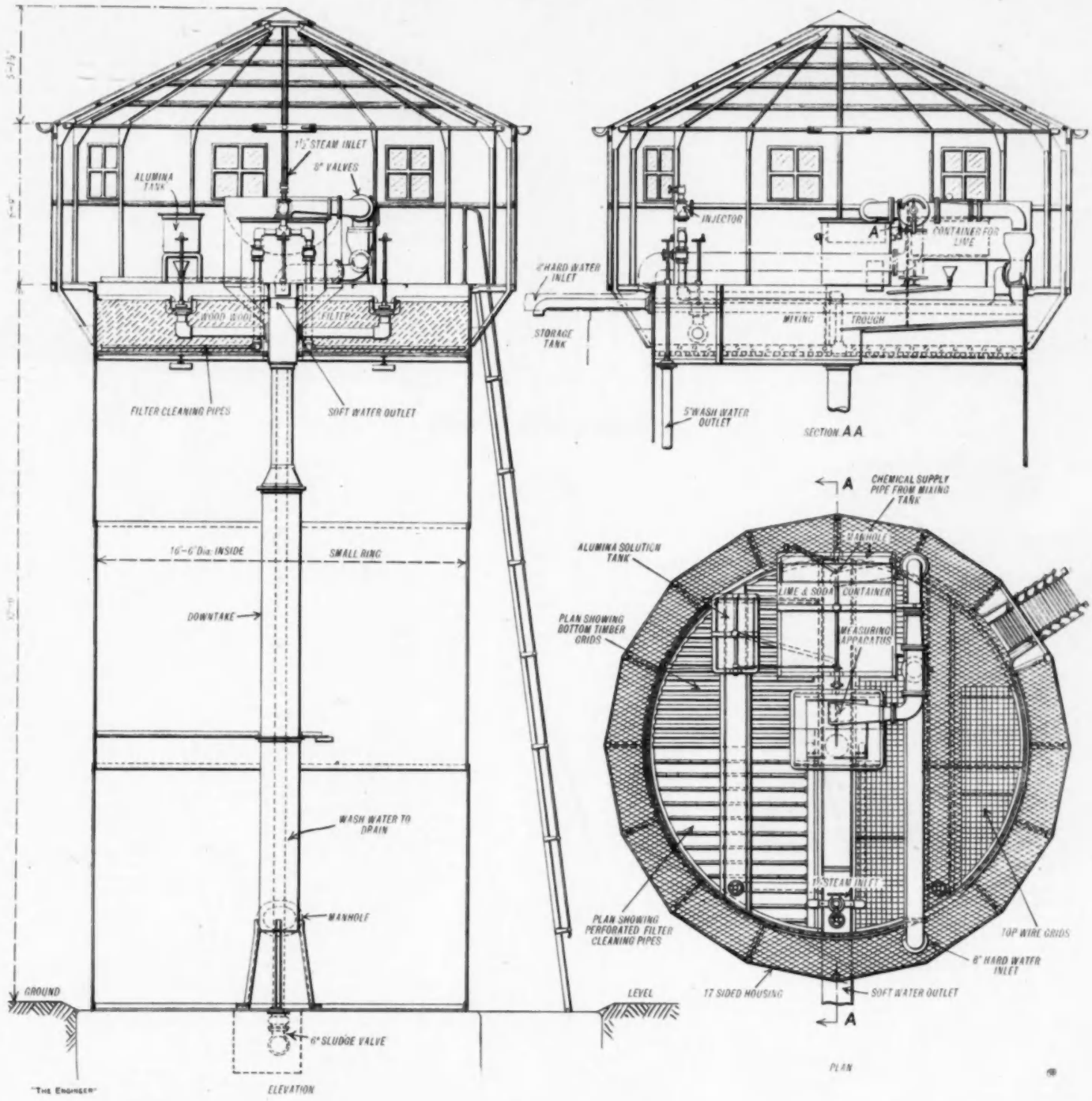


FIG. 5—SECTION OF NECAXA DAM NO. 2

THE London and North-Eastern Railway has recently conducted experiments in the use of wireless for handling goods trains in shunting yards, the object being to provide a means of communication between the engine-driver and the operator in charge of the control tower from which shunting operations are directed. The results, which are not yet published, are being considered by the Ministry of Transport, and are expected to be dealt with in an official report on various methods of automatic train control.

WATER SOFTENING PLANT AT INCHICORE LOCOMOTIVE WORKS

UNITED WATER SOFTENERS, LTD., LONDON, ENGINEERS



Water Softening Plants on the Great Southern Railways of Ireland.

ALTHOUGH water supply of good quality for steam raising is obviously one of the primary essentials in the operation of a railway system, it is a fact that, with a few prominent exceptions, the question of water treatment has not, up to the present date, received much consideration by the railway managements of the world.

Many companies, for example, possess no softening plant at all, and rely on the use of boiler compounds and periodical chipping to minimise the damage done by the scale deposited by hard water; others have been content with the laying down of a few large plants at those points on their lines where the water hardness is extreme, without troubling to deal with supplies of lesser hardness, but still scale-forming, at many intermediate places. In this connection, therefore, the policy recently adopted by the Great Southern Railways of Ireland in laying down large water softening plants on the main line system is of considerable interest to engineers.

The Great Southern Railway of Ireland is the largest railway system in the Irish Free State, having open more than 2000 miles of track, and serving as the main artery of communication between Dublin and the West and South of Ireland. Since the conclusion of the war and the settlement of the domestic troubles which followed it in Ireland, the Board of the company has been steadily devoting its attention to the improvement of the organisation throughout the system. Particular importance is attached to the provision of suitably conditioned water supplies at all points on the system where the hardness of the water is sufficient to give rise to the formation of scale in the locomotives, and the first plants have already been laid down and are in full operation.

The water softening plants are all of the Lassen-Hjort continuous automatic separate measurement type, supplied by United Water Softeners, Ltd., in which the hard water and the reagents applied to soften it are synchronously metered and mixed in relatively small, predetermined and adjustable quantities.

The plants are installed at four principal points on the main line, viz., the Inchicore Locomotive Works, Ballybrophy Depôt, Limerick Junction, and Cork Running Sheds, and the running is so arranged that the locomotives operating on this section of the line shall be fed entirely with softened water.

The accompanying drawing shows the general arrangement of the plant erected at the Inchicore Locomotive Works of the company near Dublin, and may be regarded as typical of the other plants referred to. This softener has a capacity of 350,000 gallons per day and is designed to work twenty-four hours per day for 365 days in the year; the necessary cleaning of the filters and sludging of the plant being carried out while the softener is in operation, so that it does not require laying off even for a short time throughout the whole year.

The Lassen-Hjort apparatus has been so widely used by engineers during the past two decades that its method of operation is well known, and it is necessary, therefore, to refer only to the special features of the Irish plants. The reagents are prepared at ground level in a mixing tank and are pumped by electric power at Inchicore and Cork and by steam power at Limerick Junction and Ballybrophy to the chemical container at the top of the tower, thereby avoiding all labour in taking the raw materals to the top of the plant and preparing them there. The water supply at Inchicore is taken from a canal, the level of which is higher than the top of the water softening plant, and therefore enables a gravitation feed to be arranged to the latter. As the water contains a considerable amount of matter in suspension, provision is made in the water softening plant for the addition of coagulant as and when found necessary. The flow of hard water to the measuring apparatus is controlled by a Gibbs' patented regulating valve, by means of which a determined proportion is bypassed direct to the measuring apparatus, the balance being delivered direct into the measuring trough situated below the same.

The proportions between these two discharges can be varied with great accuracy, so that the rate of working of the measuring apparatus can also be closely controlled by this means. Consequently the discharge of the chemicals administered to the supply is capable of being adjusted within fine limits. The water and chemicals flow down downtake pipes to the bottom of the plant and then rise slowly into a cylindrical tank, finally passing through a wood wool filter situated at the top of the tank and emerging softened and filtered, to be discharged into the soft water storage tank alongside of which the plant is situated.

The filter is fitted with a cleaning apparatus patented by the makers, consisting of a system of perforated pipes covering the whole area of the base of the filter. Through these pipes is circulated low-pressure compressed air provided by a steam air injector. By an arrangement of screw-down valves fitted in the collecting trough, which are provided for the even collection of the water for the filter area, a section of the filter can be isolated, and by this means the rate of flow of water through any individual section can for the time being be doubled. The upward flow of the water combined with the agitation caused by the current of low-pressure air loosens the lime deposit,

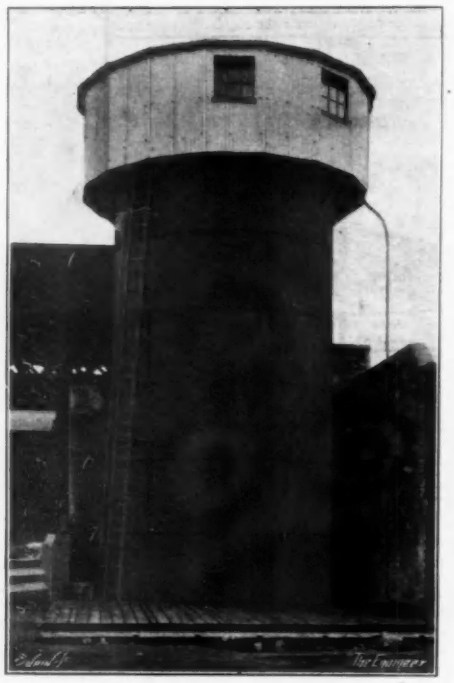
which is collected in the trough and runs away into a sludge pit.

The whole of the top of the plant is completely housed in, a platform being provided round the periphery, enabling free access to all sections of the plant for inspection and adjustment. The house is provided with windows giving ample light and air.

The crude water supply from the canal to the plant is controlled by a ball valve, this valve being operated by the level of the water in the soft water storage tank. The sludge and waste effluent from the plant is discharged into a sludge pit, which provides for the settlement of the sludge matter, the clear supernatant water being passed to drain, while the solid sludge is periodically dug out and loaded into trucks.

For the preparation of the chemicals a specially designed chemical mixing tank is provided, this being situated in the house beneath the storage tank. The mixing tank itself is 6ft. by 6ft. high and provided with a Lassen-Hjort chemical pump, which is directly driven by an electric motor through suitable worm reduction gear. This enables the preparation of the chemicals to be carried out with the minimum amount of manual labour, the whole of the mixing of the solution and the delivery of same to the reservoir of the measuring apparatus being carried out by electrical power.

At Ballybrophy the capacity of the plant is 120,000 gallons per day. In this case the chemical mixing tank is driven by means of a Ransomes, Sims and Jefferies steam



WATER-SOFTENING TOWER AT INCHICORE

engine, the drive being through belting with fast and loose pulleys. This plant is also provided with alumina gear for the addition of coagulant when necessary.

Two supplies are being treated at Cork Running Sheds, and in consequence the plant is fitted with two separate measuring apparatus, one for the treatment of Rathbeaton water and one for the tunnel supply. The Rathbeaton supply is used for a considerable portion of the year, and at other times of the year it is necessary to augment it with the other supply known as the tunnel water. Alumina reservoirs are provided in each case for adding coagulant when necessary.

The plant is situated alongside a building known as the tank house, the treated water from the plant being discharged into the storage as previously outlined for the other installations. Owing to the exigencies of space in the neighbourhood, it was necessary to place the sludge pits at some distance from the plant, and special arrangements regarding the drain pipe from the plant to the sludge pits had to be made in order to ensure that the necessary fall was available. The mixing tank is motor driven.

The capacity of the Limerick plant is 5500 gallons per hour and the mixing tank is steam driven.

THE increase in demand has caused the York Electricity Committee to recommend the City Council to spend £36,395 on a change-over from the direct current to the alternating current system of supply. The city electrical engineer reports an increase in the demand on the direct current mains of 400 kW above that of last year, although a considerable number of direct current consumers on the outskirts of the town have already been changed to alternating current. The bulk of the increase is in the centre of the city, and it has become necessary to consider the advisability of beginning the change-over in that portion, because it is there that the greatest amount of relief can be given quickly. The maximum load last year was 10,960 kW, against 9813 kW in 1928, an increase of 1147 kW. The Committee recommends that the sanction of the Electricity Commissioners to the borrowing of the sum mentioned be sought, and reports that it is considering whether any portion of the scheme can be expedited with a view to providing work for the unemployed. If so, the Unemployment Grants Committee will be asked to give financial assistance.

The Huggenberger Tensometer.

THE device, illustrated herewith, known as the tensometer, is made by Dr. A. Huggenberger, of Zurich, for whom T. C. Howden and Co., 5 and 7, Fleet-street, Birmingham, are the sole agents in this country. The instrument is a lever-type extensometer of small size, possessing, it is claimed, a high degree of precision and sensitiveness and capable of being fixed rapidly in position and with no more preparation of the specimen or member to which it is to be applied than the removal of the rust or scale from

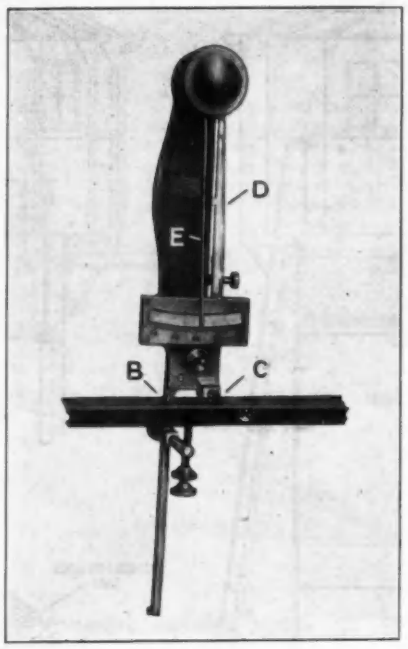


FIG. 1—TENSOMETER—LABORATORY TYPE

its surface. Various types of fixing clamps have been produced to permit its application to many forms of members, and by means of extension bars the gauge length over which the strain is measured can be varied from 1in. upwards to 40in. The device is applicable to field or laboratory use, and can be used either as an extensometer on a testing machine or to measure the strain in service of parts of aeroplanes, bridges, cranes, concrete structures, and so forth.

In Fig. 1 the laboratory form of the instrument is shown, while in Fig. 2 we illustrate the field type with an extension piece A in use. In Fig. 1 B is a fixed knife-edge and C is a tilting knife-edge. Strain occurring longitudinally

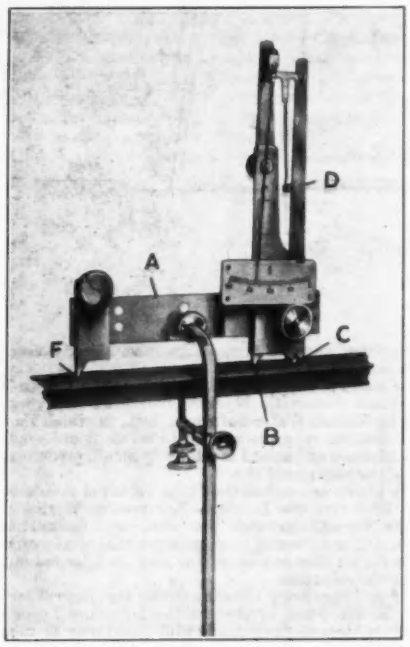


FIG. 2—TENSOMETER—FIELD TYPE

between the points B C is transmitted through the knife-edge B to the lever D, and thence through a double knife-edge and secondary lever to the pointer E. The scale across the face of which the pointer moves is furnished with a mirror to eliminate parallax effects. It is 1·9in. in length, and is graduated in divisions of 0·05in. The instrument has a multiplication factor of about 1200 to 1, and it is claimed that a strain of 0·00001in., corresponding to a pointer movement of 0·012in., can readily be read by means of it. The distance between the knife-edges B and C is 1in. The stationary knife B can, however, be reversed to give, if desired, a gauge length of ½in. The instrument weighs only 2½ oz., is 6¼in. high, and has an overall width of 2in.

In Fig. 2 the lever system is shown fully exposed. The contact C in this case is a pin forming the lower end of the lever D, but if desired the tilting knife-edge used in the laboratory type can be substituted as a refinement. The extension bar A is so arranged as to lift the knife-edge B off the specimen and to transfer the contact to the knife-edge F. Extension bars can also be fitted to the laboratory design, and in both types provision is made for adjusting the position of the pointer on the scale. The instrument in Figs. 1 and 2 is shown clamped to the specimen by means of an adjustable holder fixed in the one case to the base of the instrument and in the other to the extension bar and capable of accommodating specimens up to 4in. deep. A similar but stouter clamp is provided to take

FIG. 3—TWO TENSOMETERS AND CLAMP

specimens up to 8in. in depth. In Fig. 3 we illustrate a double clamp designed to permit two tensometers to be applied simultaneously on opposite sides of a specimen. An electro-magnetic form of clamp giving an adhesive force of 100 lb. has also been devised, while special forms are available for fixing the instrument to concrete, boiler tubes, pipes and for other special purposes.

The field type of the device—Fig. 2—has a multiplication factor of 1000 to one. It weighs 2¼ oz., has a height of 5⅞in., and is 1¼in. wide. A third design, similar to the field type, is made with a multiplication factor of 300 to one. It weighs only 1⅛ oz., and measures 4¼in. in height and 1⅞in. in width.

SIXTY YEARS AGO.

A PATENTED steam omnibus designed by Mr. Nairn, of Leith, for service in Edinburgh, was described in our issue of January 28th, 1870. A vehicle of the type was, we stated, then under construction and an extensive demand for others was anticipated. In designing the omnibus Mr. Nairn, we noted, had used every endeavour to preserve the appearance of the ordinary vehicle "so as more easily to overcome the prejudice of the public." Inside eighteen passengers could be accommodated, while on the roof a double-sided longitudinal seat was provided for thirty-two people. Fully loaded the omnibus weighed 7 tons, and in that condition, so we said, it could ascend a 1 in 16 incline at 8 miles an hour and on a level road travel at double that speed. The cost of the vehicle, we added, delivered in Leith with steam up ready to run under its own power to any part of the country did not exceed the cost of an ordinary omnibus, and its necessary stud of horses. The vehicle ran on three wheels, two driving and one forward for steering. Each wheel was 38in. in diameter by 10in. wide and was fitted with a "running face" or tire of willow wood to deaden noise and to give adhesion in frosty weather. The engine had three cylinders and was situated at the rear end of the frame almost beneath the conductor's step. It was coupled direct to the rear, or driving, axle. At the forward end was a coal-fired vertical boiler of the Field type. It was attended to by a fireman. Water was fed to it by an injector from a tank of 150 gallons capacity slung beneath the main frames. The steam—the pressure is not stated—was led to the engine by a pipe beneath the body. The smoke from the boiler was turned into a horizontal pipe forming the division between the double seat for the outside passengers and was discharged over the conductor's head. The "steersman" was accommodated on a seat in front of the boiler and controlled a reversing handle, a steam handle and a steering handle, the last named being very similar to that found on a modern omnibus. A double bulkhead separated the fireman and steersman's compartment from the inside passengers. The exhaust from the engines was superheated before being discharged as an invisible stream, and the cylinder cocks were arranged to open into the water tank. In this way "not the slightest appearance of steam or noise may be detected about the 'bus." Considerable thought was apparently given to the action of the two driving wheels when a corner was being turned. The equivalent of a differential connection was provided by making each wheel run loosely on its shaft, the driving connection being established through the medium of a V-friction brake covered with wood. Our description of the brake system is not very clear, but we stated that when the vehicle was descending a gradient steeper than 1 in 20 a three-way cock in the exhaust pipe was operated in such a way that, with the reversing handle in back gear, air was pumped into the boiler.

Railway and Road Matters.

THE exhibition of signalling and safety appliances by the Underground companies at Charing Cross, mentioned in this column on January 3rd, was attended by 186,000 people during the twenty-five days it was open.

IN an appeal for economies in railway operation, the General Manager of the South African Railways points out that accidents alone cost the Administration £40,000 a year, and pilferages and damage to goods cost £65,000.

DURING the present year 12,000 freight wagons are to be built by the L.M.S. Railway at a cost of £1,500,000. The vehicles will comprise many types, including open wagons, low-sided wagons, standard mineral wagons, covered vans for general merchandise, banana, meat, refrigerator and brake vans, cattle wagons, 20-ton steel hopper wagons, and other specially constructed vehicles.

THE Great Western is the only company which definitely has adopted a system of cab signal and automatic train control combined. The whole of the line between Paddington and Reading has been equipped for some time and during last year the system was joined up as between Old Oak Common and High Wycombe and extended from Swindon to Reading and from Didcot to Oxford. These extensions necessitated the provision of 137 ramps at distant signals.

THE matter of a deep-level tube between Hammersmith or Earl's Court and the City, in order to relieve the congestion on the Metropolitan District Railway, was recently raised in a question asked in the House of Commons. The answer showed that in the opinion of the railway company—in which opinion the Minister of Transport was inclined to agree—there are other improvements in London tube railways which are likely to be needed before any such scheme as that referred to.

AT a cost of upwards of 40,000,000 yen, the construction of the longest tunnel in Japan has just been completed. By it the journey between Tokio and Niigata (264 miles) is to be reduced by four hours. The Shinizu Tunnel, which is 32,800ft. long, pierces under the mountains separating the provinces of Kozuke and Echigo, and was begun in 1923, several years later than the shorter, but much more difficult, Tanna Tunnel. Two gangs of workers, each about 1200 strong, have been working from both ends, and credit is given the engineers for the completion of their task several months before it was expected to be finished.

ON the afternoon of January 14th, a miners' train belonging to the Blaenavon Company collided with a light engine near the company's offices in Blaenavon. A coach containing 40 workmen was overturned, and one man was so badly injured that he died on the following Friday. We record this accident mainly to emphasise the fact that the unfortunate mishap did not occur upon a public railway. Had it been otherwise, it would have spoilt the present record of the railway companies that they have not had a fatal passenger train accident, *i.e.*, one in which passengers have been killed, since the collision at Ashchurch on January 8th of last year.

THE Board of Trade returns show that the value of railway material exported during the first eleven months of the year 1929 was as follows; the corresponding figures for 1928 and 1927 being shown in brackets:—Locomotives, £2,971,833 (£3,203,773, £2,053,870); rails, £2,534,812 (£3,238,964, £3,143,363); carriages, £2,218,259 (£2,357,899, £2,923,241); wagons, £2,270,735 (£2,947,243, £2,837,202); wheels and axles, £397,580 (£696,215, £772,276); tires and axles, £569,086 (£547,515, £663,221); chairs and metal sleepers, £479,072 (£827,089, £1,332,865); miscellaneous permanent way, £952,854 (£1,227,485, £1,378,499); total permanent way material, £5,074,813 (£6,658,944, £7,531,456). The weight of the rails exported was 301,138 tons (371,836 tons, 380,000 tons), and of the chairs and metal sleepers 48,000 tons (83,697 tons, 134,736 tons). During the month of November alone the value of the locomotives sent overseas was £276,855, which included: South Africa, £98,435; the Argentine, £74,616; India, £55,572; countries in South America other than the Argentine, £8276; Australia, £1544. During the same month the value of the rails shipped was £242,414, which included: The Argentine, £48,592; South Africa, £32,952; New Zealand, £21,262; Ceylon, £13,296; India, £4506; Australia, £3794.

THE annual report for the year ended March 31st, 1929, of the general manager of the South African Railways and Harbours, to hand by the last mail, says that the electrification of the railway from Capetown to Simonstown, which was completed and on which a full electric train service was begun on September 3rd, 1928, has proved successful as a means of transport. A fast, frequent and efficient train service has been developed, working under conditions of far greater safety, comfort and cleanliness than can be expected from the competitive tram and omnibus services in the area served by the railway. In his report a year ago—page 295 of THE ENGINEER of March 15th, 1929—Mr. Moore indicated that unless the fullest possible advantage is taken by the travelling public of the electrified line the annual loss is likely to be heavy. Notwithstanding the improved facilities provided the public has, to a large extent, failed to give adequate support to the more attractive and expeditious form of transport now available, consequently since the introduction of electric operation the financial results of working the line between Capetown and Simonstown are disappointing. Before electrification the loss was at the rate of £96,000 a year; under electric operation it is not likely to be less than £250,000. Not only is the loss by omnibus competition one of the causes for the increase in the deficit, but there is the high cost of the current supplied by the Electricity Supply Commission. When the estimates were prepared there was no omnibus competition, and the consulting engineers allowed for an increased revenue of £139,500, or 25 per cent. Actually, the increase is £12,000, or 3 per cent. After discussing the high prices paid for current the general manager concludes: "If the Salt River power station was operated as a railway undertaking, there would be a direct saving of £50,000 per annum in administrative expenses and capital charges; such a saving would assist matters on the Simonstown line very considerably."

Notes and Memoranda.

IT is claimed that the Hotel Palacio Salvo, at Montevidio, Uruguay, is the highest concrete building. It has twenty-eight storeys and a total height of 338ft.

IN a paper on the water hammer erosion of steam turbine blades, presented to the University of Durham Philosophical Society, Mr. S. S. Cook says that the water hammer pressure on blading having a linear speed of 120 m. per second is about 11 tons per square inch, which is of the order of the elastic limit of many metals.

IN the official report on the failure of a Scotch marine boiler, which was caused by the pulling out of some of the stays in the combustion chamber, it is stated that "the only satisfactory method of dealing with slack combustion chamber stays is to renew them with stays made a good fit, after re-tapping the holes in the plates. Capping by welding is bad practice, as it hides the fact that the stays are slack and the welding may be called upon to take in tension the whole load placed on the stay."

THE largest high-pressure boiler installation in the world is, it is claimed, that at the Billingham Works, Stockton-on-Tees, of Synthetic Ammonia and Nitrates, Ltd., a branch of Imperial Chemical Industries. The installation consists of seven units, each unit having an output of 240,000 lb. of steam per hour at a pressure of 800 lb. per square inch, and superheated to a final temperature of 800 deg. Fah. Each boiler unit is fired with pulverised coal, and consists of a water-tube boiler, water walls, superheater, economiser and air heater.

THE following is an extract from the Board of Trade report of the formal investigation of an accident in which a Lancashire boiler exploded and killed seven men: "We desire to call attention to the finding of the coroner's jury, which was that the explosion of the boiler was an accident. In one sense, no doubt, it was an accident, inasmuch as the explosion was fortuitous and unexpected. But, although we acquit the parties from blame, we cannot say, nor do we think that any practical engineer would say that the explosion was accidental, for, in the first place, it would not have happened if each furnace had been fitted with a fusible plug. It is a matter of regret to us that these precautions were not taken, for if they had been, in our judgment, this explosion and its attendant disastrous loss of life would not have occurred."

MONEL can, according to J. R. Booer, be satisfactorily welded by most processes, and provided good penetration is obtained the resistance to corrosion is not impaired. Special precautions are necessary, and may be summarised as follows:—In all processes the weld should be built up well above the surface in order to bring any dross or impurities above the finished level. A rod of monel metal should be used, and the work executed as rapidly as is consistent with good welding. In the oxy-acetylene process a flux of boric acid should be used. In the arc process direct current gives the better results. The polarity should be reversed, *i.e.*, the electrode should be positive, and a special deoxidising alloy consisting of silicon, manganese, and magnesium, should be applied in powder form to the work and to the electrode.

IN the course of an address given before the local Society of Chemical Industry at the Birmingham Chamber of Commerce, Mr. E. J. Dobbs emphasised that chromium is no protection to metals such as brass, copper, and nickel-silver, and explained that the deposit tended to accelerate corrosion of these metals through the formation of a strong battery in the presence of moist atmospheres, with consequent corrosion of the base metal. The only safe protection was a heavy deposit of nickel on the base metal, and the plating of this with chromium after polishing. In spite of claims advanced for the practice of depositing chromium direct in commercial thickness, any chromium deposits so made broke down badly when exposed to climatic influences. A heavy nickel deposit was essential if the chromium deposit was to be enduring.

ACCORDING to an American contemporary, the Ford Motor Company has decided to install at its Rouge plant, United States of America, a 110,000-kilowatt turbine operating at 1200 lb., which will be supplied by two boilers. These boilers will have the greatest steaming capacity of any boiler yet laid down for this pressure, and will be installed in practically the same sized casing as the older boilers of the plant, which have about one-third the capacity. The turbine unit is also the largest of its type yet built. The high-pressure element will be mounted on the low-pressure casing, and both generators will be of the same size and speed, one placed above the other. Steam will be supplied at 750 deg. Fah., and live steam reheaters will heat the steam between turbines. Four-stage extraction will be employed for feed-water heating, and economisers as well as air preheaters, will be used. The fuel will be blast-furnace gas and pulverised coal.

COAL dusts vary greatly in their degree of inflammability, but there has not existed hitherto a laboratory test of this inflammability capable of replacing satisfactorily the laborious and rather costly method of repeated trial in large scale explosion galleries. The difficulties involved in producing a simple test were discussed in Safety in Mines Research Board Paper No. 31, published a year or two ago. Such a test has now been evolved and is described in Paper No. 56, by A. L. Godbert and R. V. Wheeler, just published—H.M. Stationery Office, price 6d. net. The method of test is to measure the inflammability by ascertaining the proportion of inert dust necessary to suppress inflammation when small quantities are blown by oxygen through a heated tube. It has been proved to give results comparable with the explosion gallery trials. A refinement of the same test was used to study the effect of the fineness and chemical composition of coal dust on its inflammability. Safety in Mines Researeh Board Papers Nos. 33 and 48 had shown that the inflammability of a coal dust ran roughly with its volatile matter content, but there were notable exceptions to the general rule. Paper No. 56 proves that there is a much closer relationship between the inflammability of a coal dust and the reactivity of its ulmin compounds, as demonstrated by their relative capacity for absorbing oxygen. Occluded gases were found not to affect materially the inflammability of the dusts.

Miscellanea.

THE Soviet Government is building at Batum—through the medium of its Oil Syndicate—a refinery which, when completed, will be capable of handling 3,000,000 tons of crude petroleum per year. It will be used only for export purposes, while the refineries at Baku will handle the domestic trade. Three (oil) pipe lines connect the Batum refinery with the oil fields at Baku.

SOME months ago we referred to a cement-like material called Titanite, which can be used much as plaster-of-Paris is used, but is much harder and more durable. We now hear that it is being employed by the Linotype Company, Ltd., for pattern plates with great success. They are cheaper than iron and, what is even more important, lighter. Plates up to 4ft. 6in. long by 2ft. wide, and no more than ⅛in. thick, are being used.

THE Kristianssand Harbour Board is planning various improvements to the harbour, especially in view of the time when the Soerland Railway will reach the town. Among other things, the Kaledonie quay is to be enlarged so that it can be used by ships of up to 5000 tons instead of only 2000 to 2500 tons, as at present. The quay, moreover, is to be modernised, and to be provided with a covered space in the middle and railway lines on each side.

IT has been decided that a transformer station under the South-East England Electricity Scheme shall be set up in Marylebone in connection with the following main transmission lines:—(1) Walthamstow to Marylebone, *via*, or with connections to Hackney, Poplar, Stepney, Shoreditch, Islington and St. Pancras; (2) Marylebone to Fulham; (3) Grove-road to Marylebone. The site of the transformer station will be Lodge-place, Marylebone.

FOLLOWING a recent meeting of members of the Institution of Automobile Engineers in the Leeds district, it has been decided to establish a Leeds Section of the North of England Centre of the Institution. The opening meeting of the section will be held at the Metropole Hotel, King-street, Leeds, on Wednesday, January 29th, at 7.15 p.m., when Mr. W. H. Goddard will read a paper entitled "The Diesel Engine in Road Transport," followed by a discussion.

THE 1928 Report of the Federated Malay States Posts and Telegraphs Department shows that the telephone system was extended and developed during the year at a rate hitherto unparalleled in its history. The number of subscribers on December 31st, 1928, was 4534, an increase of 531 on the figure for 1927. In addition, there were 2177 extension lines, extension bells, private circuits, private bell or alarm-circuits and tell-tale clock circuits maintained by the Department, as compared with 1871 in 1927. Thirteen new public telephone exchanges were opened in the course of the year. Junction calls showed an increase of 180 per cent. over 1927.

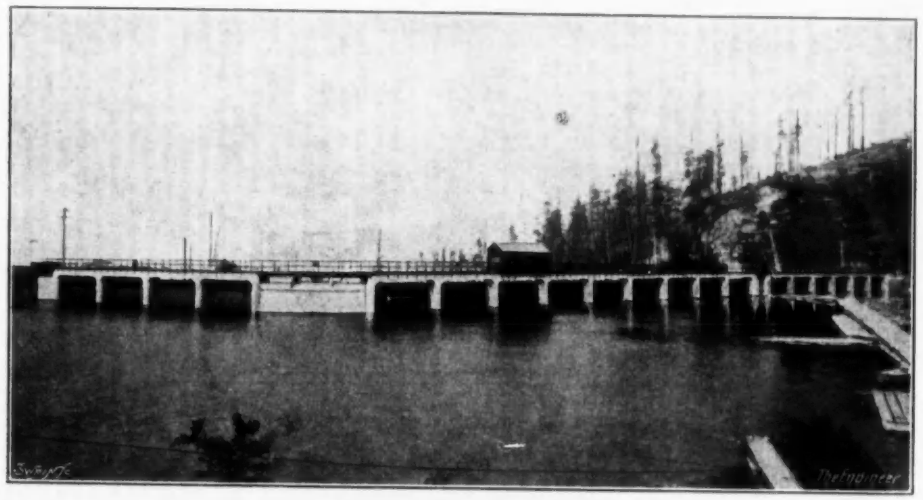
LAST August the Montreal Board of Trade commissioned Henry Holgate and J. A. Jamieson, engineers, of Montreal, to investigate and report on the St. Lawrence Waterways Improvement Scheme. The report, which was made public early in January, declares that the project is unnecessary and uneconomical, and should be opposed, and concludes with the following recommendations:—"(1) That you use your influence to oppose the carrying out of the St. Lawrence deep waterways project for the reasons given, it being an uneconomical proposition; (2) that you urge on the Government the improvement of the existing canal system to increase its efficiency to the standard of the Soulanges and Lachine canals, and (3) that you further institute inquiry into the economic situation of the Montreal Horbour and the grain transfer systems at Port Colbourne, with a view to urging on the Government such improvement as will reduce charges on the grain in transit to a figure which should reasonably be expected."

AN interesting recent addition at the Home Office Industrial Museum in the Horseferry-road, Westminster, is a small building erected in the yard to demonstrate the effects of unfavourable atmospheric conditions in workrooms and methods by which the conditions can be remedied or their effects mitigated. Means are provided for ventilating the building by regulated air movements, heating by convection or radiation and humidifying the air to any required degree over a wide temperature range. Thus, widely differing conditions can be attained, such as those found in warm humid cotton-weaving sheds, steamy laundries and dye-ho.ises, at hot furnaces, in insufficiently warmed workrooms, and so forth, and the effects of air movement, and different methods of heating, in improving the conditions practically demonstrated. It is hoped that the building will prove of interest and use not only to those concerned with industrial conditions, but also to heating and ventilating engineers, architects and others concerned with the ventilation and heating of buildings generally.

THE Government of Peru has been told by the contractors (the Frederick Snare Corporation) for the port works at Callao that, construction having proceeded more rapidly than expected, they hope to hand over the work next summer instead of in August, 1931. The improvements made at a cost of £2,000,000, which will be partly met by a special traffic tax on all merchandise entering through Callao, will include more commodious Customs warehouses adjoining the docks. Callao port is only a few miles from Lima, and not only serves the most populous region, but is also the ocean terminus of the Central Railway of Peru, the main link between the central Andean mineral area and the outside world. Callao handles two-thirds of the country's imports and two-fifths of its exports, but only vessels with full cargoes of coal, wheat and lumber can enter the dock at present. The Government is taking special measures to induce a greater use of the port by shippers, most of whom have hitherto preferred to handle cargo in the open bay by means of lighters. The changes will effect economy in time, as the delay in finding a suitable berth is avoided and cargo can be handled simultaneously from both sides of the vessels. It is suggested that landing charges, exclusive of Customs, which at present average 15 centavos per kilogramme, should be reduced, and that arbitrary extra charges levied on individual consignments should be abolished.

THE POWELL RIVER HYDRO-ELECTRIC POWER STATION, BRITISH COLUMBIA

(*For description see page* 112).



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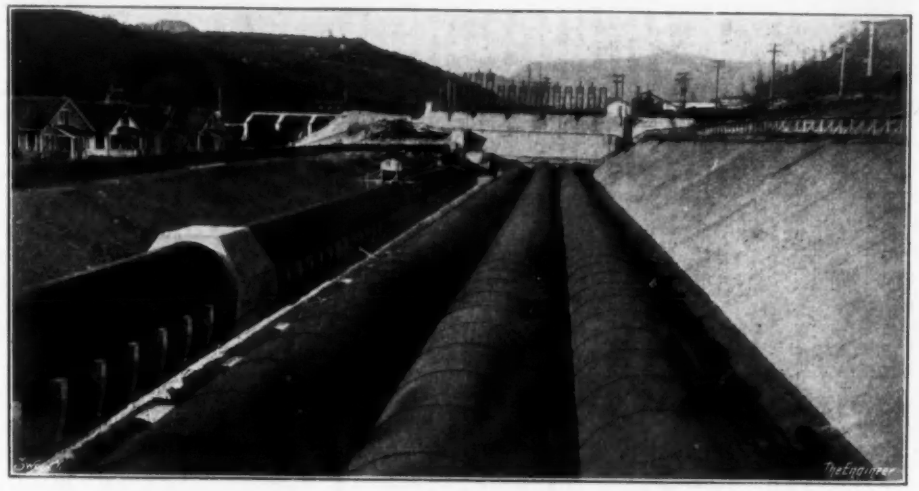

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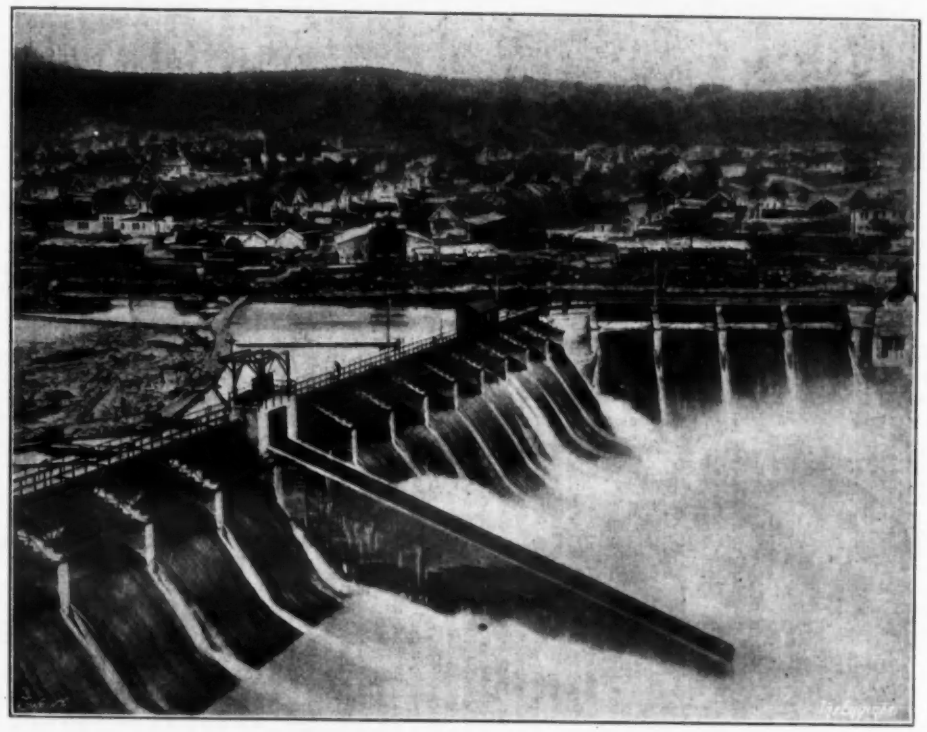

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THE ENGINEER.

JANUARY 24, 1930.

Deferred Payments.

IT will not have escaped the attention of those engineers—many in number—who follow the City news that, as a result of negotiations with the Bank of England, the authorised capital of the United Dominions Trust is to be increased by no less than a quarter of a million pounds. The Trust is an organisation for the promotion of hire-purchase, and was formed about eleven years ago by Mr. Gibson Jarvie. Mr. Jarvie, who is a Scotsman, returned to this country about that time from the United States to open a branch of a similar American concern. Meeting with success, he purchased the business and established the United Dominions Trust, Ltd., of which he is managing director. It has advanced money to meet deferred payments on a variety of products, but mainly, we believe, on printing machinery, motor cars, and household goods, such as refrigerators and vacuum cleaners. Speaking of the new issue, Sir Edward Mountain, chairman of the Trust, says in a letter to the shareholders : "It is hoped that the company will thus contribute to the development of British industry by encouraging the sale of British goods, and fulfil a need which has long been felt by manufacturers in marketing their goods."

The remarkable development of deferred payments which is signalised by this new step raises once again the question of the economics of a system which has expanded to astounding limits on the American continent, but is still looked upon askance in this country. Here we have all been brought up upon the moral maxim that we should not purchase what we cannot pay for. We are urged to save and save until we are in a position to buy, and we are warned that the mortgaging of the future is a thriftless and unhappy practice. The advocates of deferred payments will have nothing to do with these time-worn tenets. Their case is that money should be used as rapidly as it becomes available ; that it is bad economically and bad for the industries of the country to "put it away in an old stocking." They say, for example, that a printer who waits till he has saved enough money to purchase a new machine will see himself surpassed by his competitors, and will lose the profit that he might secure by the use of a better appliance. Thus he loses on both sides—by the loss of trade and the loss of profit. On the other hand, if he purchases a machine by deferred payments he keeps up with his competitors, makes more profit on the new machine than on the old, and puts his money, as it comes in, to a useful purpose. Furthermore, he assists the maker of the machinery, and, through him, the hundred and one other businesses from which he buys materials. That is but a single example out of many that might be taken. Another very obvious one is agricultural machinery ; but one of a rather different order is presented by motor cars, which are now sold in vast numbers by hire-purchase. On this point we have had the pleasure and advantage of personal conversation with Mr. Jarvie. The question was whether there is a saturation point for motor cars. We understand that Mr. Jarvie holds that there is no such point ; that, given facilities for purchase many times the present number of motor cars might be owned in this country. His view is, we believe, that one car per family is an unnecessarily low limit. Many families should have two, three, or four cars, each being reserved for its own appropriate service—one for shopping, one for the station, one for touring, and so on ! It is obvious from the facts that that is the plan followed in the United States, and that it is a possibility should give encouragement to the motor car industry of the United Kingdom.

Every business of any kind, small or great, may be regarded as a "money-pump" ; it keeps money in circulation, and that is just what industry requires. As long as money is moving, it is producing—sometimes through rather strange and indirect courses, but ultimately it is employed for production. Just as in the case of a boiler, the gases do their business most efficiently when they are moving with the greatest velocity, so with money. When its circulation is rapid, when it passes from the consumer to the producer without delay, then industry flourishes, products increase, unemployment falls off, and the country gets richer. Money then moves still more rapidly, and we reach the condition to which the United States have attained at the present time. The merit of the hire-purchase, or deferred payment, system, as we see it, is that it keeps the money flowing steadily through the "money-pump," and, furthermore, that it directs its course. It sends it straight back into the producing industries ; not through circuitous routes where some of its energy may, as the scientist would say, be "lowered," but direct into the very place where it will augment production, and still further increase the number and potentiality of purchasers. But every contract for deferred payments, whether it be by bills or by contract, becomes a debt. The volume of that debt in America must now stand at a colossal figure, and it frightens many people. They fear what the result would be did a rot set in. They visualise the collapse of industry after industry, and the bankruptcy of the whole continent. That is the orthodox view based upon the moral maxims upon which we were brought up. But those maxims may need revision. In the long run it may pay to keep the money-pump constantly supplied, and there may, in fact, be far less danger of a breakdown than we imagine. In any case, the system is extending, even in this staid old country, and it is a rather significant fact that the Bank of England should be countenancing it. It is well that we should regard it with an open mind, and not be too ready to shake our heads over a system just because it would have shocked our grandfathers.

The Unit of Heat.

WHEN the International Steam Tables Conference met in London last July the members came to a decision which was in some respects more important than their agreement as to the numerical value of certain properties of steam. It was, of course, essential to such agreement that there should be some clearly defined and generally accepted unit quantity of heat. The ordinary international metric unit, the kilo-calorie, like its counterpart, the British thermal unit, suffered from a distressing vagueness. The quantity of heat required to raise the temperature of a kilogramme of water by 1 deg. Cent. appears at first sight to be something quite definite. But whenever real exactitude is required this definition of the kilo-calorie has to be supplemented by a specification of the conditions under which the water is heated. Is the water, for example, to be raised from an initial temperature of 15 deg. or from 20 deg., or from some other arbitrary starting point ; is it

better to take a "mean calorie" defined as one-hundredth of the heat required to raise the temperature from freezing to boiling point; and, again, should the water be heated under the pressure of its own vapour alone, or should a constant pressure of one atmosphere be taken? All these questions have to be settled before one can know exactly what quantity of heat is meant by a kilo-calorie, and the various answers to them by different physicists have resulted in the use of three or four kinds of kilo-calorie, with just sufficient discrepancy between them to cause trouble in work of precision. The Steam Tables Conference, having to express heat quantities in kilo-calories, naturally had to make it quite clear what it meant when it used the term. It might have adopted one of the more usual definitions, with the hope that thereby it would have contributed to its universal acceptance. This, however, would not only have necessitated a somewhat difficult choice, but would have perpetuated the disadvantage of a unit the value of which might be changed with every fresh determination of the properties of water. The Conference therefore decided upon a much more radical course, and defined the kilo-calorie without any reference to water at all, but as a quantity of heat equivalent to a given quantity of electrical energy. Thus, at one stroke, all doubt as to the meaning of the term was eliminated, and the unit was linked up with the electrical units on which there is already an international agreement. For practical purposes, it was convenient that the new kilo-calorie, so defined, should represent as closely as possible the same quantity of heat as already connoted by the term kilo-calorie. With this end in view it was decided that for the purposes of an International Steam Table, a kilo-calorie should be the exact equivalent of 4186 joules, or in more familiar units, one eight hundred and sixtieth part of a kilowatt-hour. The closeness of the agreement between the new International kilo-calorie and the various kilo-calories based on the heating of water is shown by the fact that the mean kilo-calorie used by Callendar in his book on "The Properties of Steam" was taken as 4186·8 joules; the value taken by the Heat Engine Trials Committee was 4186·98 joules; the American Steam Tables Committee had adopted the value of 4187·6 joules, recently determined by the U.S. Bureau of Standards; while the German investigators had based their work on the 15° kilo-calorie with a value of 4184 joules. In future, at any rate for steam table work, the confusion caused by these various and possibly uncertain values will no longer exist. A kilo-calorie henceforth is one eight hundred and sixtieth part of a kilowatt-hour, and whether to heat a kilogramme of water through 1 deg. under any specified conditions requires more or less than a kilo-calorie is a matter for experiment.

This fundamental change in the definition of a physical unit is not without its precedents. Indeed, one may almost say that it is in accordance with the evolution of scientific work. The metre, for example, was originally defined as one forty millionth part of the length of a meridian. Now it is given to very few men to be able to measure a meridian, and no two who tried to do it would be likely to agree as to its exact length. Hence, the definition of the metre was changed to the distance between the ends of a certain platinum-iridium bar in the Pavillon de Breteuil at Sèvres. Similarly, the yard, which was at first the length of the arm of a certain English king, was redefined for greater convenience and permanence as the distance between two lines on a metal bar at Westminster. More apposite, perhaps, is the case of the litre. It was intended to be the volume contained in a decimetre cube, namely, 1000 cubic centimetres exactly. It was believed at the time that such a volume of water at the temperature corresponding to its maximum density and at atmospheric pressure would weigh exactly a kilogramme. This indeed was the first definition of the kilogramme. Later on, it was found that a cubic decimetre of water contained less than an exact kilogramme, so, instead of tinkering with the kilogramme, which by then was established as a given mass of metal, the unit of mass was regarded as the fundamental unit, and the litre was redefined as the volume of a kilogramme of water, which under the conditions specified amounts to 1000·027 cubic centimetres. There is, again, the instance of the redefinition of the acceleration due to gravity. This was a dreadful unit, if used with any pretence to the highest accuracy. The values of 32·2 in British units or 981·2 in metric units are only approximately correct at sea level and at Greenwich. The general value applicable to any point on the earth's surface is given in metric units by the terrible expression: $g=980{\cdot}621 - 2{\cdot}589 \cos 2\lambda + 0{\cdot}07 \cos^2 2\lambda - 0{\cdot}0003086\ h$, in which λ represents the latitude and h the height in metres above mean sea level. The first attempt at simplicity consisted in taking a value for gravity as it would be at sea level and in latitude 45 deg., and there was an international agreement that this value should be 980·665 centimetres per second per second. In time, however, it became doubtful whether this figure was really correct for the latitude and level to which it was supposed to apply, so now questions of latitude and level are disregarded and the gravitational constant is taken by American and continental engineers as having a universal value of 980·665. This may not be satisfactory to the academic mind, but it has the immense practical advantage that all calculations involving the value of g give similar results in every country adhering to the convention.

Although the London Steam Tables Conference was held with closed doors, it is probably correct to say that the American delegates—Dr. Harvey N. Davis and Professor J. H. Keenan—largely influenced the decision of the Conference to simplify the question of the kilo-calorie by defining it in terms of the electrical units. This view is rendered almost certain by a strong plea for the change, made by the same authorities in a paper on "Recent Research on the Thermal Properties of Steam," presented by them to the World Engineering Congress in Tokio last autumn. Their arguments are undoubtedly cogent. The retention of the old definition is said to put the science of thermo-dynamics "in the anomalous position of depending on a fundamental unit of heat which is not experimentally reproducible with satisfactory accuracy, even in the foremost standardising laboratories of the world, which is not known in its relation to other units to better than a tenth of a per cent., and which is not even defined with precision or in a way that is universally accepted." By abandoning all attempts to define the calorie or the B.Th.U. in terms of the properties of water, and by adopting instead a definition based entirely on mechanical or electrical constants, the difficulty could be met. The specific heat of water could then be measured in terms of the new calorie in precisely the same way that specific heats of other substances are measured. As a possible alternative to the redefinition of the calorie, they suggested dropping the use of the terms "calorie" and "B.Th.U." altogether, and expressing heat quantities directly in terms of kilowatt-seconds. Either of their proposals would avoid the troubles with the definition of heat units in terms of heating water. The redefinition of the calorie, however, appealed more strongly to the Steam Tables Conference, and we think it has the balance of practical advantages. It is now, indeed, an accomplished fact, so far as international steam tables are concerned. Sir Richard Glazebrook, who acted as an independent chairman at some of the meetings of the Conference, has expressed in a letter which we published on December 27th his dissent from the decision to redefine the kilo-calorie, although he regards the new unit as quite suitable for steam tables. That is, of course, the only use suggested for it at the moment, but if physicists desire to continue to wrestle with the kind of calorie so justly castigated by Dr. Davis and Professor Keenan, there is no one to prevent them from doing so. As far as engineering work is concerned, we think that the use of the new unit will be entirely to the good.

Literature.

Practical Design of Simple Steel Structures. By DAVID S. STEWART, B.Sc., Assoc. M. Inst. C.E., A.R.T.C., F.R.S.E. London: Constable and Co., Ltd. 1929. Vols. I., II. and III., prices, 12s., 16s. and 5s.

THE author of this well-conceived work, who is Lecturer in Structural Engineering Drawing and Design at the University of Edinburgh, has employed methods which he used when engaged in practice, modified by his experience in teaching students. This combination of qualifications has enabled him to fulfil his purpose of providing a detailed guide for young engineers and architects. His first purpose was to fill the gap which results from the failure of books on the theory of structures to give adequate guidance in the actual design and in the choice of sections, and, on the other hand, the failure of books which furnish complete drawings of structures to "... explain why the particular sections used in the design were adopted in preference to others." That there is such a gap is undeniable, and the value of Mr. Stewart's work will largely depend, for the individual engineer or draughtsman, upon how far he has filled it for himself. Probably, few engineers have done so in a manner which so usefully relates the direct designing to the choice of forms to be used and to the conditions of the manufacture and subsequent treatment of the parts employed. The reader is presumed to have a slight knowledge of theory, but the author takes the whole responsibility for introducing him to workshop practice. In the calculations elementary mathematics are employed as far as possible.

The scope of the work extends beyond its obvious purpose, as expressed in the title. An engineer or a draughtsman having a little knowledge of the theory of design and using the information and instruction which it affords, will not only be able to design, in the light of natural laws and mathematics, the structures and parts with which the author so effectively deals, but will also be enabled to design economically and reasonably in respect of the materials, forms, dimensions and finishing of parts and details supplied by manufacturers and merchants. He will know what happens when bars are straightened, rivet holes punched, rivets driven, edges machined, metal sheared, and so forth, and will realise that, in various ways, such operations may have to be taken into account as affecting the calculated strengths of parts so treated. Engineers, who should be able to give their draughtsmen all the guidance needed for design, are sometimes content to leave to those useful assistants such details as they themselves too often consider of minor importance and, too often also, have not really taken the trouble to master. Mr. Stewart's book will be an aid to more effective co-operation in this respect and will especially aid those engineers who, after designing the details from the whole, re-design the whole from the details.

The author touches, briefly but significantly, on the subject of right and wrong in regard to designs and specifications. He has had the courage to condemn, strictly from within the bounds of his own knowledge of the subject, certain undesirable practice and procedure in respect of designs and specifications, and contracts based upon them. He refers to the unjustifiable practice of allowing periods much too short for the submission of tenders, pointing out that this results in increased prices to cover the risk. He condemns the practice of asking for tenders on incomplete drawings. He states that it occasionally happens "... that the consulting engineer or surveyor, etc., having only a slight knowledge of structures," sends inquiries direct to several firms, enclosing a single line diagram, with overall dimensions and loads, asking for proposals and prices. His use of the term "engineer or surveyor, etc.," suggests that his remarks are intended to apply especially to the notoriously wrong practices of local authorities in this respect. The justification for such comments as those which Mr. Stewart makes, in a book having the *cachet* of the Glasgow series of text-books, of which Mr. G. Moncur is editor, lies in the fact that he supplies something which may aid the efforts of consulting engineers to regain the confidence of the public, which, unreasonably and foolishly, has been so largely diverted to concerns which play the two incompatible parts of consultant and contractor.

The first volume of the set—Shop Practice, Riveted Connections, and Beams, &c.—deals in the first three chapters with rolled sections, the drawing-office, the template loft and the works. The succeeding chapters cover all kinds of fastenings, riveted joints, splices, excentric riveted connections, wind pressure, and beams; concluding with a study of the forces acting on crane girders, which leads up to an example of the design of a crane gantry girder.

Volume II., Plate Girders, Columns, Trusses, &c., carries the subject forward to the design of plate girders, the design of a 40ft. span gantry girder, studies of axially loaded and non-axially loaded columns and their foundations, the design of a 55ft. span roof truss, of a lattice girder footbridge, and of a 70ft. span through railway bridge. There is also a chapter on live loads and one in which trusses, portal trusses and columns are discussed as preliminary to an example of the design of a workshop.

Volume III., Tables, includes the usual tables of equal and unequal angles, channels, I-beams and tees. Less usually provided in handbooks and other publications are a pitch multiplication table, a table of the usual holing for angles and other sections, and one for net sectional areas for all possible paths for tearing, in angles with double rivet lines.

Volume I. is complete in itself, though in its use the tables of Volume III. would considerably reduce the time taken in designing. Volume II. is obviously complete in itself for the purposes of some designers, but its value for most engineers, and especially draughtsmen, will be greater if the first volume also be at hand. The tables, separately furnished in Volume III., can be judged from the contents as already described.

Both volumes of the book proper are well illustrated by appropriate drawings and diagrams in the text, and Volume II. is furnished with plates reproducing specification drawings, with dimensions and all other information properly shown thereon. They comprise the drawings for the 40ft. crane, the 53ft. roof truss, the 45ft. workshop roof truss, the footbridge and, four plates, the railway bridge. Many references

to sources of further information are given at the ends of chapters.

The book may be recommended as likely to be useful to all concerned with the design of steel structures, simple or elaborate.

The Principles and Practice of Lubrication. By Prof. A. W. NASH and Dr. A. K. BOWEN. London: Chapman and Hall. 1929. Price 15s. net.

ALTHOUGH there are more elaborate treatises for the use of experts dealing with this subject, a manual such as this is sure to be very useful to those who wish merely to understand the salient features of the theory of lubrication and its practical application. The subject is treated in as non-technical language as possible, and those whose knowledge of physics and chemistry is slight should have no difficulty in following the author's reasoning, especially when practical matters are concerned.

In the introduction, Chapter I., are reviewed some of the fallacious beliefs and misunderstandings that are current regarding the properties of lubricating oils. Here we have the meaning of viscosity, flash point, specific gravity, colour, &c., properly explained, and it is pointed out that the thinning down of lubricating oil with kerosene (paraffin oil) in cold weather is harmful, for the decreases thus brought about in the lubricating value and viscosity of the liquid are out of all proportion to the quantity of diluent added. In such cases a less viscous oil is recommended.

Chapter I., which treats of friction in its various forms, may be said to give the author's views on some aspects of the theory of lubrication. As the treatment of the subject only occupies 36 out of 307 pages of the manual, it will be clear that the problem is only dealt with in outline. Here the conditions of dry friction, rolling friction, boundary friction, are described; but although many of the experiments on boundary or threshhold friction made by Sir William Hardy and others are referred to, the authors regard their significance in what appears to be a somewhat novel manner. Thus we read that a good lubricant for boundary conditions can be said to be one which is strongly attracted by the solid, whereas a poor lubricant is less strongly attracted.

In the case of the fluid friction of lubricated bearings, the theory of Osborne Reynolds, based on the experimental results obtained by Beauchamp Tower, is clearly stated in non-mathematical language. In this form of bearing the "brass" is floating upon a comparatively thick film of oil, which is automatically carried in between the two opposing surfaces, owing to the fact that the radius of the "brass" is larger than that of the journal. In the case of the Michell bearing the flat surfaces are supported so that they automatically incline themselves to each other.

Chapter IV. deals with specific gravity and viscosity. It is pointed out that although the specific gravity of an oil is still quoted occasionally in specifications, from the point of lubricating power it is unimportant. The value of a knowledge of it arises when the nature of the crude oil from which the lubricating fraction was obtained is in question. Simple instructions are given for its determination, and some of the commoner forms of measuring instruments are figured.

Viscosity, which the authors regard as equivalent to "body," is more fully dealt with, and is regarded as being, perhaps, the chief physical property to be known when considerations are made regarding the selection of an oil for a desired purpose; the authors sharing the modern view that oiliness can, at present, only be determined by actual frictional tests. A number of viscometers are described, including those adopted in the British Engineering Standards Association Specification No. 188, 1923. Methods are also given for the conversion of standard values into poises.

Many designs of bearings and methods of lubrication are considered in Chapter IV. In this section it is emphasised that the metallic and other substances used for rubbing surfaces vary in unctuousness, some metals when in rubbing contact giving higher frictional values than others, both when clean and when using the same lubricant. Here it may be mentioned that the threshold frictions shown in Table 24, page 81, were obtained when the lubricant was Bayonne mineral oil. A good general idea of the design of radial, thrust and slipper bearings will also be found in this chapter, together with the metals and alloys most generally used for particular purposes. At the end of the chapter is a useful summary of a number of matters of outstanding importance.

The remainder of the manual, about half the work, deals with the sources of lubricants, and their chemical and physical testing, subjects on which the authors are well-known experts.

Chapter VIII. deals with industrial lubrication practice, and Chapter IX. with mechanical friction testing machines. Here it is freely admitted that no known chemical tests indicate much beyond the nature of the oil, *i.e.*, they do not tell us its lubricating power. On this account the engineer is faced with the problem that when several competitive oils are submitted, he needs something more than the mere specification in order to enable him to select the best oil for the purpose in view. Although the machine for which the oil is to be used gives the best test as to which is the better lubricant, numerous mechanical testing machines, which give valuable information, have been devised. A number of such machines are figured and described.

This useful and well-printed manual finally gives a chapter on the care of lubricants, and a useful appendix of physical data.

La Brique Armée Homogène dans la Construction Générale. By L. ATTHENONT. Paris: Librairie Polytechnique Ch. Béranger, 15, rue des Saints-Pères. 1929. Price 90f.

IT is seldom that the French language fails in logical expression, but it is necessary to point out that, whether or no *briquetage* would have been the better word, the title must be translated "Homogeneous, Reinforced Brickwork in Construction Generally," the sub-title being "Its Calculation Simplified, according to the Rules applicable to Homogenous Bodies."

The author's main purpose is to prove that brick can take the place of concrete in steel-reinforced structures, and is, in many respects, to be preferred. Though the book is of a strictly technical and scientific character, the author introduces the subject as one which needs an advocate, referring in his graphic but shrewdly written preface, to the ambushes of prejudice, incredulity (*surprise*), and ignorance which beset the almost unexplored road which he is taking, and stressing the significance of the opposition of the more substantial forces of opposed interests and of preference for the line of least resistance.

Now an *architecte-ingénieur*, the author, as an old campaigner, has had experience of the resistance of brickwork when attacked by the gunner or the sapper. British war experience confirms his impressions, while it is well known that when a hole is being made through a brick wall, the bricks, even when of good quality, may yield more readily than the joints. Turning to the bearing of natural conditions upon the economics of the subject, Mr. Atthenont points out that in many regions far from the sea and watercourses there may be no sand or gravel, but clay is usually to be found in such tracts. Apart from these general considerations, some weight may be given to the suggestion, in the use of the term "opposed interests," that reinforced brickwork, as a method of construction in competition with others, has not had a fair chance. If, in this country, it has not, it is largely because the cement industry is better organised for publicity, marketing, and manufacture than is any other, while it is also far better organised than is the clay worker's industry in respect of equipment and research, the latter form of activity being a potent aid to publicity and the establishment of confidence.

Armed with the results of scientifically carried out experiments and with an array of calculations supported by those results, the author has made a gallant and skilfully organised attempt to supply deficiencies in respect of our knowledge of the capabilities of the brick in steel-reinforced construction. The most interesting and important of his studies relate to bricks proper, holed for reinforcement, but he extends his descriptions and calculations to cases in which the brick elements are not in the brick or block class, as regards shape. Some of the methods described, such as the construction of reinforced hollow tile floors and cellular reinforced building, are such as have been employed in this country for some time, but the more important of the calculations and laboratory tests relate to bricks and brickwork in the ordinary sense of the words. The typical case is that of a brick of 4·5 cm.×15 cm.×30 cm., the 4·5 cm.×15 cm. section being shown upright, as in section of a beam, with three equally spaced holes, the upper and lower of which have each a 20 cm.×10 cm. steel bar embedded in mortar, these bars being 10·6 cm. apart, between centres. This detail is necessary in order that the present reader may realise that the most significant feature of the book is provided by the calculations and laboratory tests relating to beams of such a section, formed of a course of reinforced brickwork and heavily loaded in the tests. Developments in the form of the brick include an example with large upper and lower holes and three pairs of intermediate holes. Calculations are furnished and the results of tests given for cross sections reinforced through the top and bottom, and externally with piano wires in a coating of cement mortar enclosing the brick. Calculations are also given for cases in which the main, or all, the reinforcement is in the joints, the bricks having the holes as provided in those already described or being solid and rectangular or I section.

The subject is developed, as bearing upon construction, in which the material other than steel and mortar is provided in separate elements, brick being the material described as so employed, with studies of the adhesion of the steel and the brick to the mortar, the resistance to shear, and the elasticity of the material. Fifteen laboratory tests of brick element reinforced beams are described, and the very interesting results given, with the author's comments on the deductions to be made from them. Examples are given of the application, actual or contemplated, of reinforced brickwork to a great range of structures, including columns, poles for telegraph and power transmission lines, beams and joists of various forms, floors, walls, water tanks, and conduits, retaining walls, piles, factory chimneys, and barges.

Whatever may be the views of individual engineers and architects as to the merits of reinforced brickwork and the range of its useful application, or those of clayworkers as regards the manufacture of the more important forms of brick described, this book is one which cannot be ignored. As a carefully prepared treatise on an important subject, it may be commended to architects and to engineers concerned with structures in a wide field.

SHORT NOTICES.

High Voltage Cables. By L. Emanueli. London: Chapman and Hall, Ltd. Price 8s. 6d.—In an introduction to this book, which is based on a series of lectures before the Engineering Faculty of the University of London, Professor C. L. Fortescue points out that only a short time ago a cable operating at 10,000 volts and carrying 5000 kVA was regarded as a triumph of the cablemakers' art, but to-day the demand is for cables carrying 100,000 kVA, or even more, at voltages of over 200,000, and that such development is not the result of haphazard hit-and-miss methods, but of a critical theoretical investigation, exact measurement, and a full understanding of the practical working conditions. Mr. Emanueli is, of course, a well-known authority on high-pressure cables; in fact, no one engineer has carried out so much work in the development of really high-pressure cables, and the present volume can scarcely fail to prove of value to those who are interested in this important branch of electrical engineering. The book is composed of five chapters corresponding with the author's lectures, and an endeavour has been made to provide information that is not usually available in text-books. A brief outline of general cable construction and the types of cables available, is followed by a section on impregnating compound and by another section on the electro-static field. The dielectric of a cable is then considered from the point of view of its impregnation, and finally the mechanical and electrical properties of the finished cable are considered. As Professor Fortescue remarks in his introduction, the book should appeal to all engineers irrespective of whether their interests are primarily electrical or otherwise, if only as an example of the effect of the scientific method of engineering production. Few better illustrations of the value of research can be found, and if the book should lead to more and more investigation of the properties of insulating materials, that alone will justify its publication.

Highway Curves. By Howard Chapin Ives. London: Chapman and Hall, Ltd. 1929. Price 17s. 6d. net.—Summarising, with discrimination, State highways practice in the United States, the author furnishes the formulas and mathematical tables for the calculation of curves, describes the procedure in setting out, and explains, with examples, the problems that have to be solved, dealing usefully with super-elevation, widening at bends, and vertical curves. The ten-chord spiral is fully explained. More than half the book consists of tables, including, besides the usual trignometrical functions, properties of the circle, and so forth, such as reduce the labour of curve calculations in respect of offsets, corrections, and the functions of the ten-chord spiral and other curves. The subject of earthwork calculations is included, a part of this matter, as well as the chapter on spirals, being reproduced from "Field Engineering" (Searle and Ives). The chapter on location—20 pages—is good, practical matter, no attempt being made to discuss the subject in relation to a general policy or the wider topography. Having regard to the nature and distribution of available information on the subject of this book, which is of pocket size, it is likely to be in considerable demand in this country.

BOOKS RECEIVED.

"*Mechanical World*" *Year Book*, 1930. London: Emmott and Co., Ltd., 20, Bedford-street, W.C. 2. Price 1s. 6d. net.

Survey of the Import Trade of India, April–September, 1929–30. London: The Department of Overseas Trade, 35, Old Queen-street, S.W. 1.

Pioneers of Electrical Communication. By Rollo Appleyard. London: Macmillan and Co., Ltd., St. Martin's-street, W.C. 2. Price 21s. net.

Workshop Receipts for Manufacturers and Scientific Amateurs. Supplementary volume. London: E. and F. N. Spon, Ltd., 57, Haymarket, S.W. 1. Price 5s. net.

Meteorological Report for the Year 1923 *of the Physical Department of the Ministry of Public Works, Egypt.* Cairo: The Sale Room, Ministry of Finance. Price P.T. 40. 1929.

Annales des Ponts et Chaussées, 1929. *Fasc. V., Septembre-Octobre:* (1) *Partie Administrative*, (2) *Partie Technique.* Paris: A. Dumas, 6, Rue de la Chaussée-d'Antin. 1929.

The "Practical Engineer" Electrical Pocket Book and Diary, 1930. Edited by Conrad Arnold, A.M.I.E.E. London: The Oxford University Press, Amen House, Warwick-square, E.C. 4. Price 2s. 6d. net.

Water Pollution Research: Summary of Current Literature (Department of Scientific and Industrial Research). Vol. III.: No. 1, January, 1930, Abstracts Nos. 1–119. Published by H.M. Stationery Office. Price 1s. 3d. net.

The World's Sugar Industry. By Lewis Eynon, B.Sc. (Lond.), F.I.C., being the twelfth Streatfield Memorial Lecture, 1929, delivered before the Institute of Chemistry of Great Britain and Ireland. London: Published by the Institute, 30, Russell-square, W.C. 1. 1929.

The Use of Calcium Chloride or Sodium Chloride as a Protection for Mortar or Concrete Against Frost. By W. N. Thomas, M.A., D.Phil., A.M. Inst. C.E. Being Building Research Special Report No. 14 of the Department of Scientific and Industrial Research. London: H.M. Stationery Office, Adastral House, Kingsway, W.C. 2. 1929. Price 9d. net.

A Japanese Balancing Machine.

WITHIN the past three years or so Mr. S. Kuno, of the Mitsubishi Research Laboratories, has invented and developed an interesting form of balancing machine by means of which, it is claimed, the amounts and positions of the weights required to balance a rotor can be determined with great accuracy in a relatively short time. So far as the particulars of the design and operation of the machine which we have received are concerned, the factor which it measures is the dynamic unbalance of the rotor. It is, however, implied in the information at our disposal that it is also applicable to the static balancing of rotors. No details of the specific manner in which it is employed statically have, however, at present been supplied to us.

In Figs. 1 and 2 we illustrate a 60-ton example of Mr. Kuno's machine as built and erected at the Mitsubishi Nagasaki Works in March, 1927. In Fig. 1 A is a bearing block suspended by means of thin elastic plates B B between two columns C C in such a way as to be capable of transverse horizontal oscillation. By turning the hand wheel D the block can be clamped to the columns, and its oscillatory freedom suppressed. Inside the block a bearing capable of swivelling freely round a vertical axis is provided for the rotor shaft. The opposite end of the rotor shaft is similarly supported. In this way, it is possible to test the rotor with either end of its shaft supported in a swivelling, but otherwise fixed, bearing, while the other is free to oscillate horizontally under the action of the unbalancing forces. In use, the rotor is run up to a suitable speed by an electric motor E. Thereafter, the driving connection is broken by slipping the clutch F, Fig. 2. The apparatus G—duplicated at the other end—is then employed to measure the amplitude and relative phase of the rotor motion, and thereby to determine the direction and magnitude of the unbalancing force existing in it.

FIG. 1—60-TON DYNAMIC BALANCING MACHINE.

The measuring apparatus G is shown in detail in Figs. 3 and 5. The bearing *a*, supporting the rotor shaft, transmits its oscillatory motion to a concave oscillating mirror *n* through a shaft *m*. At the same time the rotor shaft drives through a flexible coupling *b* a three-phase alternating-current generator *c*—shown also in Fig. 1. The three-phase current is employed to drive a synchronous motor *d*, the speed of which is made the same as that of the rotor *r* being balanced. The synchronous motor is provided with a hollow extension *e* to its shaft and inside this extension there is fitted a tilting lever *h* carrying at its end a plane mirror *i*, the inclination of which can be altered by means of a hand wheel *j* and the mechanism shown at *k*. The stator of the synchronous motor can be rotated axially by means of the hand wheel *f*, and, as a consequence, the relative phase of the rotating mirror *i* and the rotor *r* being balanced can be adjusted. The hand wheels *j* and *f* are provided with a magnitude and a phase dial respectively.

A ray of light projected through a small hole in a lamp *o* is reflected by the mirrors *n* and *i* on to a fixed reflecting mirror *p*, and thence on to a screen *q*. If the mirror *n* alone is in oscillation, the spot of light on the screen will oscillate horizontally. If the mirror *i* alone is in rotation, the spot of light will follow a circular path on the screen. If the mirror *n* oscillates and the mirror *i* rotates, a combined figure will be produced. In Fig. 4 an example is given of the figures produced by altering the inclination of the rotating mirror *i*, while in Fig. 7 there is shown the group of figures produced by turning the stator of the synchronous motor *d* through stages of 30 deg. at a time. When the figure becomes a vertical straight line, a very marked change of shape accompanies a slight alteration of the tilt or of the phase. This fact is employed as the basis for determining the magnitude and direction of the unbalancing force in existence in the rotor.

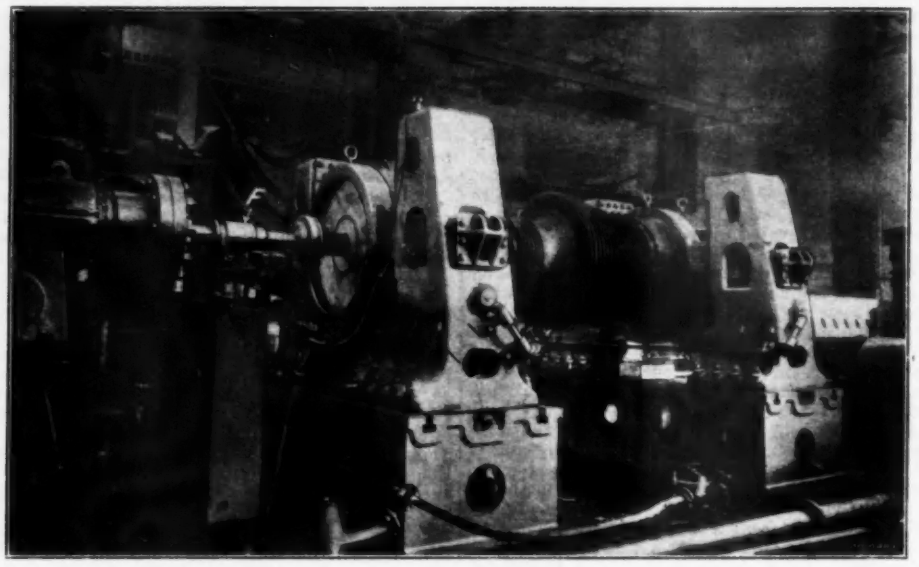


FIG. 2—DRIVING END OF BALANCING MACHINE

If the figure on the screen is a vertical straight line, the amplitude of oscillation of the mirror *n* and the radius of rotation of the mirror *i* are equal, and their phase difference is 180 deg. Hence when the figure is brought to a vertical straight line, the reading of the dials *l* and *g* enable the magnitude and direction of the unbalancing force to be determined. The direction of the required balancing weight is determined by a direct reading of the phase dial *g*. The amount of the required weight is determined from the reading of the magnitude dial *l* by multiplying it by the weight of the rotor and by a coefficient.

It is claimed that usually 45 minutes is sufficient for measuring the unbalance at the forward and aft bearings of a rotor, and for affixing the required balance weights. Thereafter, the procedure is repeated for the correction of second order errors. The result gives, it is said, a nearly perfect degree of balance. As a check, known weights may be fitted at two or more points for each bearing, and their magnitude and position determined by the apparatus, and compared with their known values. The complete balancing process, including this check, can, it is stated, be carried out in a total time of about three hours. As to the accuracy of the process, we are informed that the equipment is capable in the case

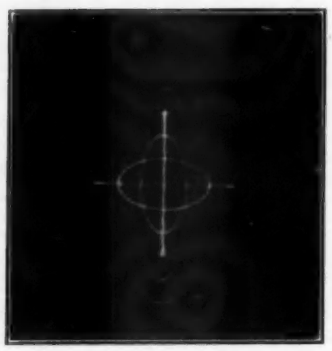


FIG. 4—OPTICAL FIGURES—CHANGE OF MAGNITUDE

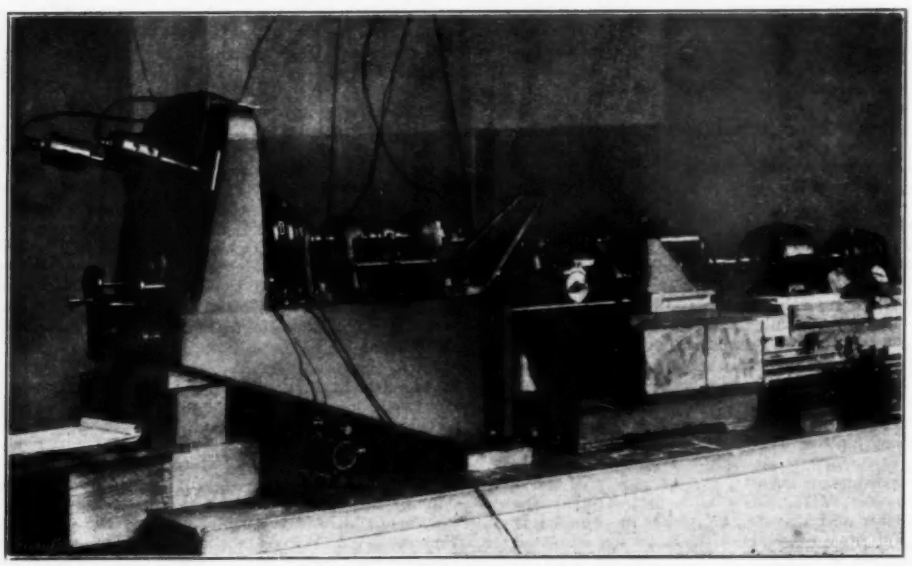


FIG. 3—GENERAL ARRANGEMENT OF MEASURING APPARATUS

of ordinary steam turbine or electrical rotors of reading an excentricity of the centre of gravity down to as small an amount as about 0·0005 mm., or, say, one fifty-thousandth part of an inch.

The theory underlying the use of the equipment may be explained by reference to Fig. 6. Any force of unbalance can always be represented by two component forces of unbalance in two arbitrary planes. These two components are represented in Fig. 6 by

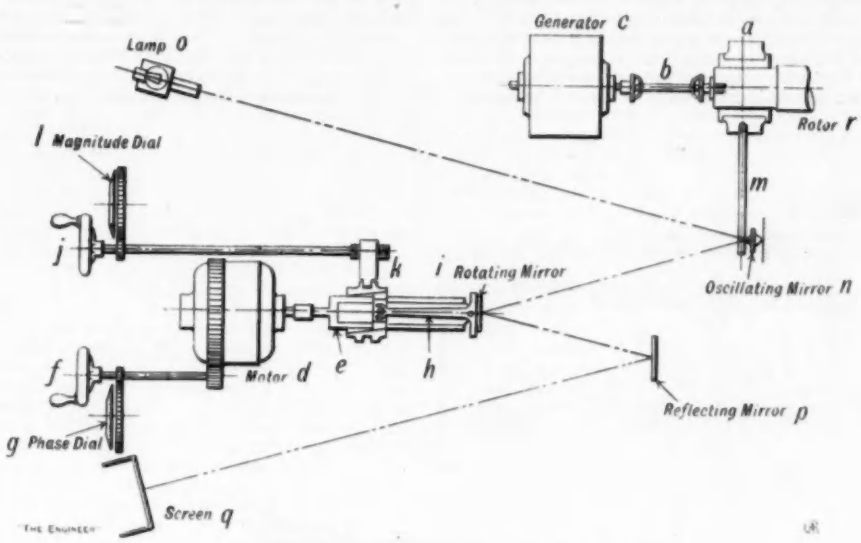


FIG. 5—DIAGRAM OF OPTICAL MEASURING SYSTEM

$m r_A$ and $m r_B$ in the planes of the bearings A. B. If the bearing B is pivoted while the bearing A is free to oscillate, the oscillation of bearing A will be affected only by the unbalancing force $m r_A$. At a speed considerably higher than the resonance speed of the bearing, the amplitude of oscillation of the bearing A will be given by—

$$z = m r_A l^2 / J ;$$

where J is the moment of inertia of the rotor about the bearing B and l is the distance between the bearings. If the total mass of the rotor is M, and if it is assumed to be concentrated at the mid point between the bearings, then $J = M l^2/4$. For ordinary turbine rotors, &c., the moment of inertia is about 20 per

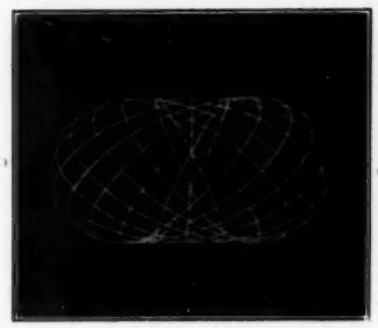


FIG. 7—OPTICAL FIGURES—CHANGE OF PHASE

cent. greater than this value. Hence, it may be assumed that $J = 1{\cdot}2\,M l^2/4$. It therefore follows that—

$$m r_A = 1{\cdot}2\,M Z/4.$$

If then the scale of the magnitude dial l—Fig. 5—is divided in terms of $x = 1{\cdot}2\,Z/4$, we have—

$$m r_A = M x.$$

In Fig. 6 let C and D be the planes in which the balancing weights are to be added. Then by the usual principles the force of unbalance $m r_A$ at A is equivalent to two forces of unbalance at C and D respectively, given by—

$$m_{AA} R_A = \frac{a+c}{c}\, m r_A,$$

$$\text{and } m_{AB} R_B = \frac{a}{c}\, m r_A.$$

If $m r_A$ is in the direction 0, the balance weight m_{AA}, as determined by the first of these relationships, should be fitted in the direction 0+180°, and the balance weight m_{AB} in the direction θ. The coefficients by which the reading of the magnitude dial after multiplying it by the mass of the rotor are to be multiplied in order to obtain the required balancing weights are therefore—

$$p_A = \frac{M}{R_A}\frac{a+c}{c} \text{ and } p_B = \frac{M}{R_B}\frac{a}{c}.$$

The treatment for the case of bearing A pivoted and bearing B oscillating is identical.

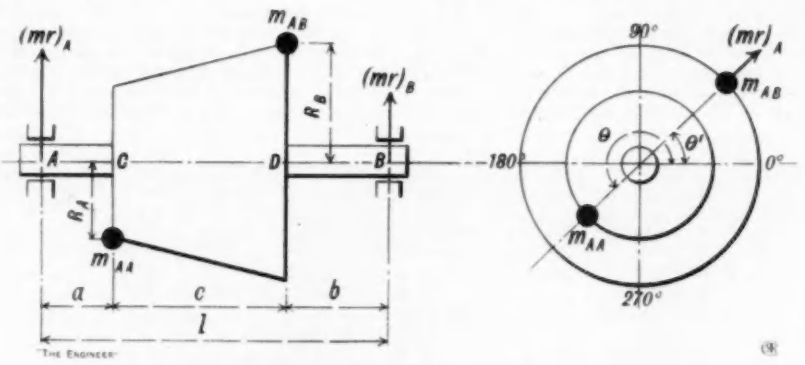


FIG. 6—DIAGRAM ILLUSTRATING THEORY OF BALANCING MACHINE

The assumption that $J = 1{\cdot}2\,M l^2/4$ may in the worst conditions lead to an error in the figure for the moment of inertia of the rotor of about 20 per cent. The accurate value of J might be calculated, but the process is tedious and lengthy. The inventor of the equipment therefore prefers to take this expression as accurate in the first instance, and after applying the balance weights indicated by its use to repeat the test and apply correcting weights on the same basis. In special cases a second correcting test may be run.

South African Engineering Notes.

Compressed Air for Railways.

IT has recently been decided to purchase compressed air for working the various machines operated by air power in the Locomotive Depôt of the South African Railways at Germiston, from the Victoria Falls and Transvaal Power Company, Ltd. The Administration has a small compressor plant at Germiston, but it is now fully loaded, and operations which could have been carried out more efficiently by air power have had to be done by obsolete hand-power methods. It has been found more economical to purchase air than to lay down more plant for its production. The V.F.P. compressed air system makes available a supply which for all practical purposes is unlimited.

S.A.R. Road Motor Service.

The road motor services operated by the S.A.R. Administration continue to expand. The latest bulletin of the General Manager shows that the total open route mileage at September 21st last was 10,448, in addition to which 1857 miles had been authorised. There can be no question that the extensive development of these services has stifled many a proposal to construct additional branch lines which, though without economic justification, would in many cases have so much political influence as to compel serious attention. On the other hand, the Administration's heavy vehicles, which do not contribute to the funds of the Road Departments, have in many instances proved a sore trial and a serious problem to the latter. Railway lorries, wet weather and earth roads form an incompatible combination and there is a need for a higher and more expensive class of road. The report of the Roads Competition Commission will probably deal adequately with this important question.

Roadmaking Machinery.

The demand for roadmaking machinery is increasing with tremendous rapidity and has not yet by any means reached its peak. Recently, the Divisional Council of Somerset East decided to place orders for further roadmaking plant at a cost of £1314. The new plant will consist of a 30 H.P. caterpillar tractor, a grader and scarifier, a special road ripper unit for macadam roads, and a 6-ton roller. The Divisional Council of Richmond (Cape) is raising a loan, £1200 of which is to be spent on road machinery. Stellenbosch and Paarl Town Councils are raising loans of £40,000 and £30,000 respectively for road construction work, and are going to use roadmaking machinery, though the amount to be expended in that direction has not been stated. The Administrator of the Cape Province has now sanctioned the raising by the Port Elizabeth Divisional Council of £125,000 for the reconstruction of a large portion of the main road between Port Elizabeth and Grahamstown. The length of the portion to be made up is about 35 miles, and the Divisional Council is proceeding to order over £12,000 of roadmaking machinery. Probably, as a result of the large orders that have been placed in the last year or two, British manufacturers of roadmaking machinery are now entering the South African market, notably Ruston and Hornsby, who have many units for street-making machinery, including tar and bitumen plants, at work in municipalities. The large sums of money voted by the Government for the making of new roads and reconstructing of old ones, has, no doubt, been responsible for much of the new move. The superiority of British machinery has been recognised over a long period of years, and therefore it is not surprising to find that already a pretty fair amount of British-made machinery, including crude oil engines, graders, portable compressors, root scarifiers, crushers, steam wagons, oil road rollers and mechanical shovels (¼ yard) are already coming forward. Why British manufacturers did not move before is difficult to understand, but from the present activity it would seem they intend to make up for lost time.

Metallurgical and Mining Congress.

Prominent mining engineers and metallurgists from all parts of the Empire have signified their intention to visit South Africa to attend the third (triennial) Empire Mining and Metallurgical Congress which will meet in South Africa from March 24th to May 9th next, and during that time will tour the Union and the two Rhodesias, covering approximately 7000 miles by rail. The Congress will open at Cape Town on March 24th, and after a stay of three days in which to make visits to various places in the Cape Peninsula, will proceed to Kimberley to view the De Beers diamond mines. Johannesburg, the centre of the gold-mining industry, will then be visited, and members will be afforded opportunities of inspecting deep-level mining in its various forms, and also viewing in operation some of the latest and most up-to-date gold-recovery plants in the world, as well as the largest gold refinery. From that centre visits to platinum mines and industrial works are being arranged. In Southern and Northern Rhodesia interesting developments in zinc, lead, asbestos, coal, chrome and gold, as well as the great copper deposits, which promise to be the largest and most important hitherto discovered, will be available for inspection. In the Transvaal and Natal various coal mines and electrical power stations will be visited. Technical sessions will be held at different centres, at which papers dealing with the latest phases of mining and metallurgy will be presented and discussed. Some sixty papers have already been received. An interesting programme, outside the sphere of the Congress's labours, has also been arranged, and includes visits to the Great Zimbabwe Ruins and Victoria Falls and the Sabie Game Reserve.

Improving Durban Harbour.

It is announced that decisions taken by the S.A. Railways and Harbours Administration with regard to the port of Durban will initiate plans that will make Durban the finest harbour and the best equipped in the Southern Hemisphere, at an ultimate cost of over £1,000,000. When the improvements are completed, the port will have the largest crane south of the Equator, and it already has the biggest grain elevator, the biggest graving dock and the biggest tug. Shed accommodation of such dimensions as will ensure swift and efficient handling without any congestion, is to be provided. A decision, after full consultation, with regard to a new deep-water berth, will be arrived at as soon as possible this year. About April next the port will begin to handle the first consignments of manganese ore from the Postmasburg deposits near Kimberley, for which purpose a new wharf has been constructed. The quantity to be shipped the first year is guaranteed to be 300,000 tons, and 400,000 tons for the next and following years. That will mean at least thirty-five extra steamers visiting Durban, and taking coal and stores the first year and about forty extra steamers each year after.

An Iron and Steel Institute.

A movement has been started in Johannesburg to form an iron and steel institute. The sponsors intend to form a committee to deal with propaganda for finding markets for the primary and secondary products of the iron and steel industry. This, it is estimated, will save the Steel Board a large sum of money, as it is proposed to appoint a prominent commercial man to fill the post. The institute will be formed on the lines of the iron and steel institutes of England and Scotland, and an executive has already been appointed to found it.

Powell River Hydro-Electric Plant, British Columbia.

PULP and paper companies in British Columbia have been responsible for a very substantial share of the water power developments in that province. Out of a total of 473,000 developed horse-power, installations in connection with pulp and paper plants aggregate approximately 81,000 horse-power. The largest of these developments is that of the Powell River Company, which has many interesting features. Powell Lake has a total area of 47 square miles, and its watershed encloses an area in excess of 500 square miles. The maximum draw-down of 22ft. provides a storage of over 600,000 acre-feet. The run-off averages around 3000 c.f.s. with peaks of up to 37,000 c.f.s. The dam, which is of the gravity type, has a maximum height of 58ft. and a spillway length of 600ft. Flood discharges are passed through nineteen Taintor gates, each 25ft. in width by 12ft. in depth. These gates are built on structural steel frames, the upstream faces being lined with tongued and grooved boards. The lower edges of the gates are equipped with rubber sealing strips, seating on a fitted wooden sill, which is embedded in the concrete, while the sides are sealed by means of a short flap of rubber insertion, secured to the gate face and bearing on the concrete buttresses. The gates are operated by a travelling electric hoist mounted on a trolley that traverses a track laid on beams supported by the gate buttresses. The hoist can be manipulated by one man, who is constantly kept on watch at the dam. The spillway has a total discharge capacity of over 90,000 c.f.s., so that it can effectively pass the maximum flood that is to be expected to occur.

The flow of water to the penstocks is doubly controlled, the water passing first through emergency head gates into a small forebay. These gates are of steel, and have bronze guide and sealing strips seating on cast iron ways embedded in the concrete gate structures. They are eight in number, and control openings 8ft. 6in. by 10ft. in size. Operation is by means of an electric hoist, which is so arranged that any individual gate can be moved or so that all the gates operate together. Under normal conditions the gates are interconnected and held "all open" to a uniform height above the seal, so that in case of trouble the gate man can, from his cabin, release the brake and start the hoist motor, when all of the gates will run down to the closed position. From the forebay, gates admit water to each of the four penstocks independently, so that any one penstock can, in case of necessity, be closed down. These gates are also electrically operated from the gate man's cabin. The forebay provides a site for inclined trash racks, which are arranged for manual cleaning.

The plant, as originally designed, was intended to supply power to a 250-ton paper mill, but the mill was later extended to have a capacity in excess of 500 tons. Owing to that fact the power plant consists of two distinct installations. In the first, three penstocks supply water to three electrical units and four direct-connected grinder units; while the second installation consists of a single penstock supplying water to two direct-connected grinder units and one electrical unit. The three original penstocks, installed when the first development was made, about 1910–11, are each approximately 11ft. in diameter, 1460ft. long, and are of steel construction, with the exception of No. 2, in which an intermediate section is built of wood stave. Each penstock is equipped with a small surge tank 10ft. in diameter and 36ft. in height, extending approximately 8ft. above high lake level. All these penstocks are equipped with bellows type expansion joints. The penstocks are controlled at their lower ends. In the case of No. 1, which supplies water to three generator wheels, the control is effected by motor-operated butterfly valves, while in the case of penstocks Nos. 2 and 3, each of which serves two grinder turbines, the control is by hand-operated valves. Each penstock is further protected against surge by bursting plates.

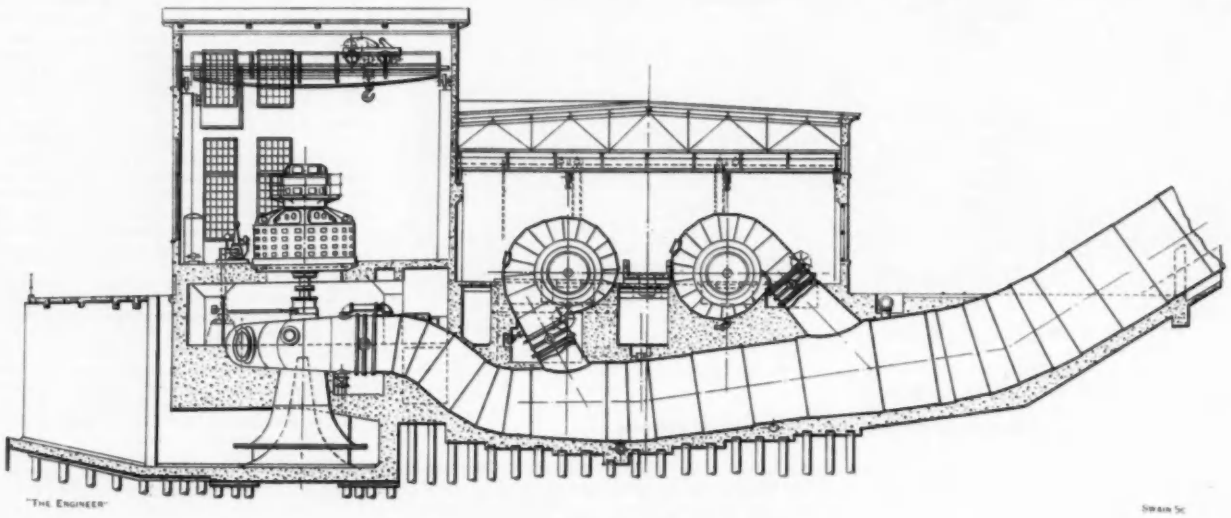
No. 4 penstock was installed comparatively recently and is of steel throughout. It is 14ft. in diameter and 1650ft. long. Stuffing-box type expansion joints were used in this case, and special precautions were taken to ensure the penstock freedom to slide through the concrete cradles, the cradles themselves being lined with graphited strips of asbestos sheet packing. A surge tank 30ft. in diameter and 40ft. in height was provided to take care of surges due to governor action, and at the lower end the flow is controlled by three motor-operated butterfly valves, two of which are installed in connection with the 6180 horse-power grinder turbines, each 6ft. in diameter, while the third, installed in connection with the 13,500 horse-power generator turbine, is 8ft. 6in. in diameter. The penstock is protected against surge by a governor and a pressure-operated relief valve.

The original generator room contains two horizontal shaft Allis-Chalmers water-wheels, each driving a Canadian General Electric Company's alternating-current generator of 2800 kVA, and one Platt horizontal shaft turbine driving a C.G.E. generator of 3750 kVA. All of these units operate at 375 r.p.m. and generate at 2300 volts. The original plant was built for 50-cycle operation, and the generators were arranged for 550 volts; but during recent extensions it was found desirable to replace the old stators with new ones of higher capacity, and the station voltage was raised at the same time. Consideration was given at the time to the possibility of also changing the frequency of the plant, but such a change would have involved such extensive replacement of existing mill machinery that the proposal had to be abandoned, and Powell River remains one of the extremely few generating plants on the continent which operate at 50 cycles. The more recently provided generator room contains one vertical-shaft Dominion Engineering Company's turbine, direct connected to a C.G.E. 12,000-kVA, 2300-volt, 50-cycle, three-phase generator, the whole unit being arranged for complete distant control from the switchboard, which is installed in the No. 1 plant, some 450ft. away.

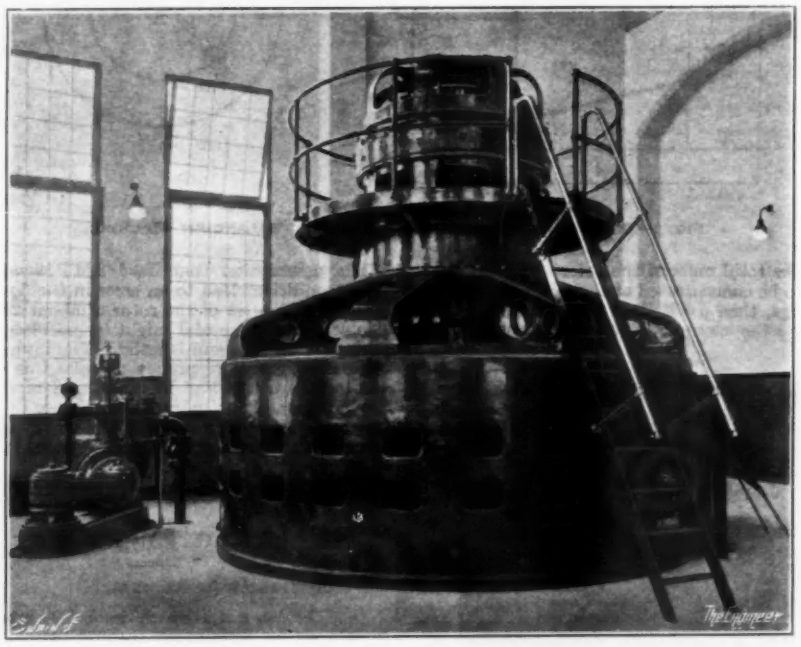
Every effort has been made to ensure continuity of operation, especially by the duplication of auxiliary machinery and its automatic control. Thus the governor oil pressure is supplied, normally, by a water-wheel-driven gear type pump, equipped with a pressure-controlled governor, while, as a standby, there is an electrically-driven pump which automatically comes into service in case the pressure drops below 115 lb. per square inch, the small wheel governor being set to maintain 135 lb. per square inch. It is interesting to note the extremely low speed at which the water wheel operates to maintain the oil pressure under normal conditions, and the sensitiveness of its governor. As with the governor oil pressure system, both the generator and wheel oiling systems are equipped with duplicate pumps, automatically controlled, as provision against failures of the primary equipment.

Duplicate equipment is brought into action automatically by means of pressure or float-controlled switches, which switches at the same time sound an alarm in both of the generating rooms, and by means of an annunciator indicate to the operator the position of the trouble. The signal remains in operation until the attendant manually operates an alarm switch. This action on his part indicates that he has received the warning, while at the same time it resets the alarm, so that it will again operate in case of failure of the duplicate equipment. The general alarm system is also so arranged that it will give the operator warning in case of governor belt breakage or should the main generator thrust bearing become heated. The temperature of all generator and wheel bearings are read every fifteen minutes by the wheel man in No. 1 plant by means of electric temperature indicating devices.

In operation, all the generators run in parallel and the large unit is allowed to govern the whole plant, the smaller units running with a constant gate open-



SECTION THROUGH THE POWER-HOUSE



12,000-kVA 2300-VOLT THREE-PHASE GENERATOR

ing and with their governors set at slightly over synchronous speed. In order to give the operator control of the large unit, its governor is provided with apparatus for distant control of the gate opening limiting device and of the shut-down arrangement, both of which operate directly on the governor pilot valve. The governor is also equipped with a gate-opening indicator, the indicator itself being installed at the main switchboard. The operator at the switchboard keeps his gate-opening limit set slightly above the gate opening required to carry the prevailing load, so that in case of governor failure the large unit cannot pick up more load than can be dropped by the smaller units. This arrangement has been subjected to practical demonstration on several occasions, and has worked without any noticeable disturbance of frequency, and it has to be remembered that frequency disturbances are particularly noticeable in paper mill operations.

Electrical protective devices installed in the plant include definite-time over-current relays, differential relays, and reverse power relays. The over-current and differential-current relays are so arranged that they will trip out the breaker, at the same time sounding an alarm and indicating on a tell-tale the circuit on which trouble has occurred. The relay also, and in the same operation, prepares the trip circuit for the field breaker, which latter is actually tripped by an auxiliary switch in the oil circuit breaker. The reverse power relay is so arranged as to give an alarm and indicate the source of trouble on the tell-tale board. A simple interlock has been introduced so as to make it impossible for an operator to close a generator breaker until he has inserted the synchroscope switch plug for that generator. In this way the accidental closing of a generator circuit breaker is, to a very large measure, guarded against. Another interlock makes it impossible for the field breaker of any generator to be operated electrically while the main breaker is closed.

Excitation is normally by means of current supplied by a 200-kW exciter carried on an extension of the 12,000-kVA unit shaft, this exciter having enough capacity to operate the whole plant. As a standby, a motor generator set is installed in No. 1 plant, which also can carry the whole load, while each of the smaller generators has its own exciter and can be run as an independent unit. There is a second motor generator in No. 1 plant, which can be used as a further spare, though it is normally used for battery charging work in connection with the electric locomotive trucks, &c., in general use around the plant.

A separate room has been set aside for the accommodation of the 2300-volt circuit breakers. That controlling the 12,000-kVA generator circuit is a 4000-ampère motor-operated oil circuit breaker, while the circuit breakers controlling the three smaller units and the ten outgoing feeders are all interchangeable 1200-ampère truck type units. These truck type switches are arranged in two rows of concrete cells placed back to back, with a bus tunnel running between them, the bus itself being fed from one end by the 12,000-kVA unit, and from the other end by the three smaller units, and being provided with disconnectors so that any part of the plant may be isolated at will. Tubular copper conductors were used for distribution within the switch room, the whole arrangement presenting a very neat and workmanlike appearance.

The control of the whole generator plant, including that of the wheel governors, exciter rheostats, generator circuit breakers, and ten feeder circuit breakers, is grouped on a single bench and instrument type switchboard only 19ft. in length. All the circuits are provided with indicating and recording meters. The instruments indicating the governor gate-opening and gate-limiting device setting and the stator temperature indicator are also arranged on this board, while Tirrill voltage regulators are fitted on a separate board standing at right angles to the main board, where they are easily kept under supervision without causing undue congestion of the latter. A 125-volt direct-current control circuit is supplied from a separate source, with a battery floating on the line so as to ensure continuity of supply, and emergency lighting in both generator rooms is provided from the same source.

The direct-connected power units include two 3600 H.P. twin Allis-Chalmers turbines, two 3600 H.P. single discharge Platt turbines, and two 6180 H.P. single discharge Dominion Engineering Works wheels, all of which are direct coupled to three-pocket grinders. The really interesting feature in connection with these wheels is the method of governing, which, in each case, is by means of the grinder pocket pressure. A gate opening is selected that will give the desired speed—about 250 r.p.m.—when the wheels are running under normal condition, with a pocket cylinder pressure of, say, 60 lb. per square inch. Should the wheel speed tend to increase by reason of one or more of the pockets being released for re-charging purposes, the pocket pressure is automatically increased so as to load up the remaining pockets, thus holding down the wheel speed.

As a standby, and primarily for use in case of low water in the lake, two steam turbine-driven generators are installed, each having a capacity, when operating on dryer steam, of about 800 H.P. The governing of these units, which feed directly back to the main busses through two of the feeder circuits, is by means of back-pressure controllers, so that when operating they deliver to the plant all the energy that can be generated by the steam used by the dryers, no make-up steam being used on the low-pressure side of the turbines. These turbine-driven generators can also be used in case of breakdown of the main generator plant, and they have a capacity, when exhausting to atmosphere, of a maximum of 1500 kVA each.

In conclusion, a few words as to the plant load may be of interest. The total connected load is just over 22,000 H.P., and it includes something like 570 motors. The general policy has been to make all motors of 50 H.P. and upwards work at 2200 volts, while motors of less than 50 H.P. operate at 550 volts, and transformers are arranged in the various departments of the mill to step down the supply for that purpose. All groups of 2200-volt motors are provided with current-limiting reactors as a protection against excessive short-circuit conditions.

No power is either purchased or sold; hence the load requirements may be accurately foretold, and, with records of lake run-off extending over a period of nearly twenty years, power available may also be accurately forecast with reasonable certainty. The generator plant has been developed to the full economical lake capacity and power; surplus over paper mill requirements is therefore available for disposal elsewhere. For that reason there has been installed a 500-kW electric steam generator.

Synchronous motors have been installed wherever possible, with the result that the power factor, without the electric boiler, is above 80 per cent., while when the boiler is in operation the power factor will run up to 90 per cent.

In an earlier paragraph it was mentioned that an intermediate section of No. 2 penstock was originally installed in wood stave, and a rather interesting piece of safety work has recently been applied to this section. The wooden penstock ran partly through a tunnel under certain buildings where both ventilation and inspection were difficult, and the possibilities of trouble in case of failure were somewhat disturbing. It was therefore decided to encase the wooden pipe completely with a concrete jacket; this work was carried out without interruption of mill operation and apparently with complete success. The concrete is reinforced so that it will, in case of complete failure of the wooden pipe, carry the full hydrostatic head, while an additional margin of safety will undoubtedly be afforded by the presence of the hoops used to band the original pipe. These hoops were sand-blasted so as to ensure that the new concrete got a good bond to the steel; the sand blasting also tended to cut away the soft parts of the wood staves, so that it is likely that there will be considerable adhesion of the wood to the concrete also. All these factors, together with the constant and total saturation to which the wood staves will now be subjected, should tend to prolong the life of the wood and postpone the day when the old pipe will finally disintegrate. Trouble was anticipated by reason of the breathing of the penstock interfering with the setting of the concrete, but actually the method of procedure seemed entirely to overcome the difficulty, and the finished job is completely free from cracks and in only one or two places are there any signs of porosity.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DEFFERED PAYMENTS.

SIR,—It is pleasing to see Mr. H. C. Siddeley's criticism of Mr. Thomas' Manchester speech in your issue of the 17th inst., and with your permission I would like to add a few comments.

In short, the scheme seems to be loading up industry with greater overheads than ever, if, as Mr. Siddeley points out, not only must the credits be issued for the re-equipment of the works, but they must also be made available to help the marketing of the resulting products.

Works thus rationalised—this is what it amounts to—will necessarily have more money passed through them per annum to pay their way, because, presumably, the loan has to be repaid some time and interest paid thereon meanwhile. It is, of course, true that the unit cost of production, owing to the improved plant, would be considerably reduced, but the total turnover of the business must be increased, for the reason given above.

Further, we know that rationalisation and improved machinery mean the replacing of human labour by machinery and consequently the difficulties of selling will be just as great to industry as a whole, although to the particular rationalised firm the position will be improved.

The export credit scheme, which has been fathered by several Governments, is all very well for the firm exporting, because it gives that firm an order, but if the importing country fails to pay, as is so often the case, this country as a whole has made a present of goods and services and is therefore physically poorer.

In effect, export credits are credits to consumers, because the country to which the goods are exported is a consumer. If this principle of consumer credit is admitted as a necessity to encourage trade, would it not be far better to give those credits to British men and women to enable them to buy the product of our own industry? In any case, in this latter event we should have the complete satisfaction of knowing that our own people have benefited.

After all, it is buying by individuals that promotes industry, even heavy industries, and therefore if trade is to improve, the money must be paid into the hands of the producer *viâ* the consumer. The consumer, in return, must receive money in excess of what he receives, either in wages, dividends or salaries.

That this principle is being more and more admitted is shown by the interest the Bank of England has taken in financing consumption, in association with Mr. J. Gibson Jarvie, of the United Dominion Trust, Ltd., and it is in directions of this kind that I think we shall find a solution to our problem of trade stagnation—not so much in export credits, which amount to a device for dumping goods into unwilling markets in many cases.

R. GAUDIN, A.M. Inst. C.E.

London, January 22nd.

PROFESSOR RATEAU.

SIR,—May we draw your attention to one small mistake which occurs in the obituary notice on Professor Rateau in your issue of the 17th inst.?

You state that Professor Rateau developed the gas turbine-driven supercharging compressor in collaboration with Messrs. Farman. This, however, is not accurate. The idea of combining an aero-engine, an exhaust gas turbine and a compressor belongs to Professor Rateau alone. The collaboration with Messrs. Farman refers only to the gear-driven compressor which does away entirely with a gas turbine, in driving the compressor through gear from the engine shaft. It is for this latter apparatus that the disengageable clutch mentioned in your article is made use of.

For and on behalf of Société Rateau,
London Branch Manager,
F. RIEDER.

London, W.C. 1, January 23rd.

THE IRON AND STEEL INDUSTRIES IN 1929.

IT is reported by the National Federation of Iron and Steel Manufacturers that the number of furnaces in blast at the end of December was 162, a net decrease of 1 since the beginning of the month. The production of pig iron in December amounted to 643,000 tons, compared with 631,400 tons in November and 540,400 tons in December, 1928. The production includes 190,400 tons of hematite, 259,700 tons of basic, 144,300 tons of foundry and 24,700 tons of forge pig iron.

The December production of steel ingots and castings amounted to 661,200 tons, compared with 815,000 tons in November and 683,100 tons in December, 1928. The December output figures bring the total for the year to 7,579,500 tons of pig iron and 9,654,700 tons of steel ingots and castings, compared with 6,610,100 tons and 8,519,700 tons respectively in 1928.

The following table shows the average monthly production of pig iron and steel ingots and castings in 1913–1920–1926 to 1929 and the production in each month since December, 1928:—

	Pig iron. Tons.	Steel ingots and castings. Tons.
1913, monthly average	855,000	638,600
1920, " "	669,500	755,600
1926, " "	204,800	299,700
1927, " "	607,700	758,100
1928, " "	550,900	710,400
1929, " "	631,600	804,600
1928, December	540,400	683,100
1929, January	563,900	764,600
February	519,600	774,900
March	590,500	859,900
April	611,300	808,600
May	654,800	843,800
June	657,800	830,900
July	671,900	804,800
August	682,000	753,300
September	664,600	847,900
October	688,700	889,800
November	631,400	815,000
December	643,000	661,200

CATALOGUES.

JONES AND LAMSON MACHINE COMPANY, 19, Water-lane, E.C. 4.—A number of illustrations showing the capabilities of "J & L" lathes.

STEWARTS AND LLOYDS, Ltd., 41, Oswald-street, Glasgow.—A 150-page loose-leaf catalogue giving detailed specifications of tubular steel poles.

MOSS GEAR COMPANY, Ltd., Crown Works, Birmingham.—Leaflets No. 17 and 18 on "Double Helical Gears" and "Planetary Speed Transformers."

VICKERS Ltd., Vickers House, Broadway, London, S.W. 1.—A fifty-page brochure dealing in some detail with the products of the Vickers' group of companies.

SMITH AND GRACE, Ltd., Thrapston, Northants.—Catalogue "A," dealing with cast iron pulleys which are made in all sizes and of all types by the firm.

HENRY HOPE AND SONS, Ltd., Smethwick, Birmingham.—A fifty-two-page brochure describing in detail and showing several installations of Hope's glass roofing.

DOWDINGS MACHINE TOOL COMPANY, Ltd., Vauxhall.—Catalogue C920 of Messrs. Schuchardt and Schütte A.G., for whom Messrs. Dowdings are the sole British agents.

CARRIER-ROSS ENGINEERING COMPANY, Ltd., 101, Regent-street, London.—A booklet describing the making and some installations of the Carrier-York heat-diffusing unit.

DORMAN, LONG AND CO., Ltd., Middlesbrough.—Catalogue of engineering castings suitable for blast-furnaces, steel works, and mills of all descriptions, made at its Clarence Works at Middlesbrough.

8,000,000 CU. FT. WATERLESS GASHOLDER AT SOUTHALL

R. AND J. DEMPSTER AND CO., LTD., MANCHESTER. ENGINEERS

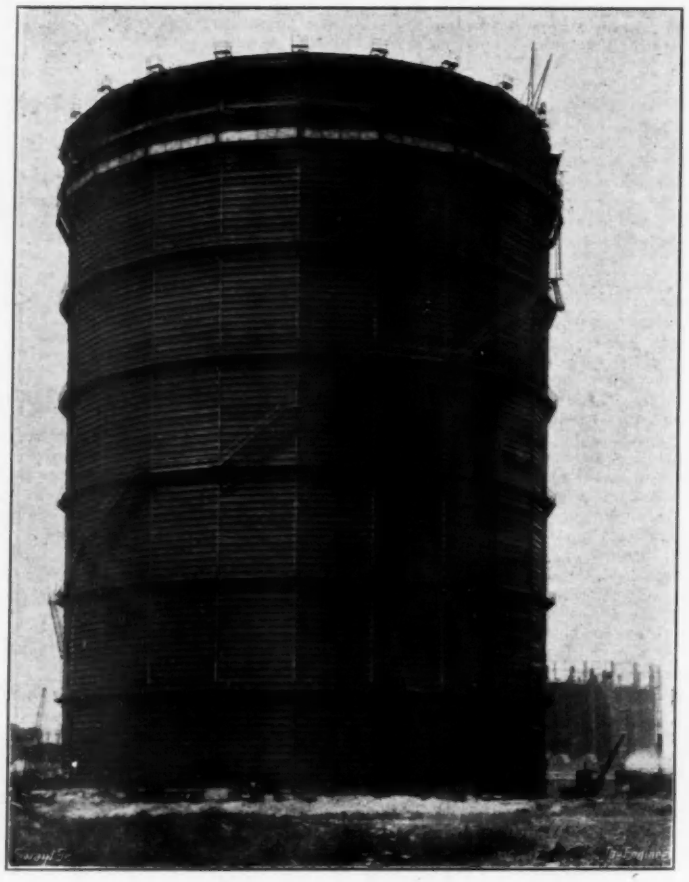


FIG. 1—THE GASHOLDER NEARING COMPLETION

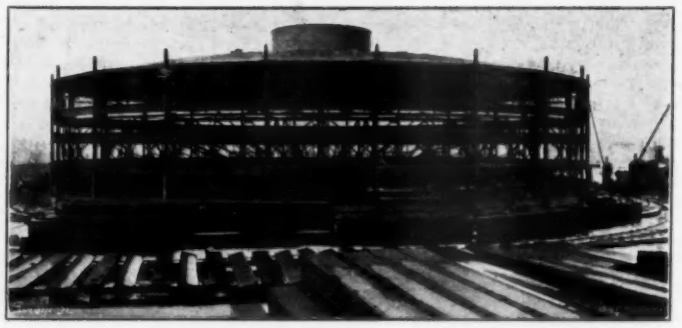


FIG. 2—AN EARLY STAGE IN ERECTION

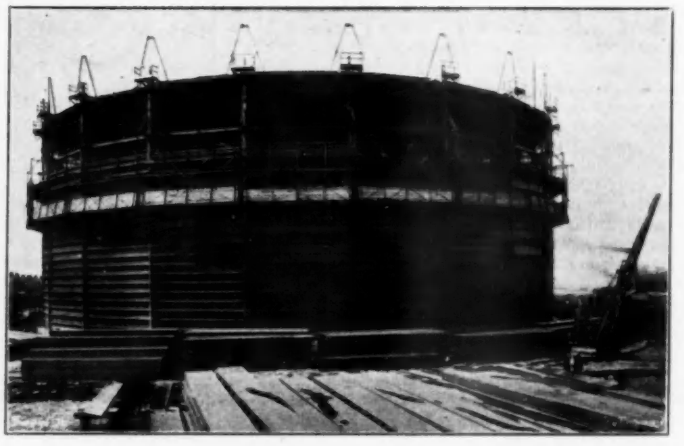


FIG. 3—ERECTION OF SIDES IN PROGRESS

A Large Waterless Gasholder.

THERE has recently been completed at Southall a "waterless" gasholder of 8,000,000 cubic feet capacity, which has been built to the order of the Gas Light and Coke Company by R. and J. Dempster and Co., Ltd., of Manchester, under M.A.N. patents. We are indebted to the owners and builders, and also to the Waterless Gasholder Company, Ltd., of 13, Rood-lane, London, E.C. 3, for the following technical particulars.

The holder at Southall, which is shown in the accompanying engravings, is not the first of its kind to be

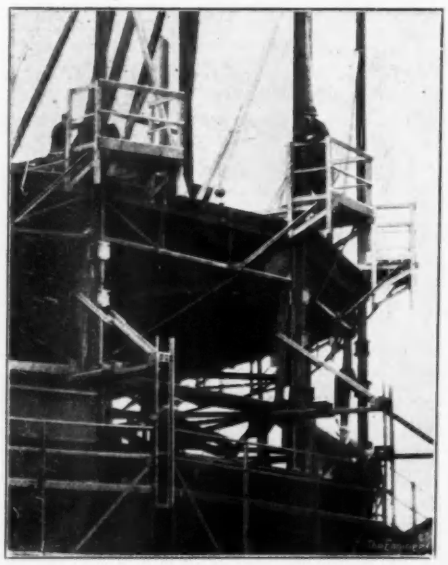


FIG. 4—ROOF RAISING ATTACHMENT

erected for the Gas Light and Coke Company. Similar holders were put in commission in 1928 at Staines and Woodford, whilst others are on order for the company's Kensal Green and Brentford stations. The Southall holder, however, has the distinction of being not only the largest of the five waterless holders for the Gas Light and Coke Company, but it is the largest of the type yet ordered in this country. This type of gasholder, although introduced in Germany some fifteen years ago, has but recently established itself in Great Britain. The credit for installing the first of the type in England belongs to the Ipswich Gas Light Company, which in 1926 placed an order for one of 2,000,000 cubic feet capacity, which was brought into operation the following year. There are now either in use or on order in Great Britain eighteen such gasholders, which range in capacity from 250,000 cubic feet upwards, and represent a total storage capacity of more than 40,000,000 cubic feet of gas. It is of interest to note that, up to the end of December, Germany had eighty-four in service, while the United States had forty-one. In all, 203 have been ordered for various countries of the world, the aggregate storage capacity amounting to well over 552,352,000 cubic feet.

The weight of sealing water necessary for an 8,000,000 cubic foot gasholder of the ordinary type would not be less than 45,000 tons. This water, and the tank to hold it, are, in the case of the waterless gasholder, entirely dispensed with, and the foundation work is accordingly simplified. In the absence of water, moreover, no risk of freezing in cold weather is to be feared, and the gas also passes forward into the mains in a much drier condition.

Details of Construction.—As shown in the illustrations the holder is a fixed polygonal structure, composed of pressed steel side plates, and having a steel bottom. It has a weather-tight, self-supporting roof with a storm-proof ventilator at the centre. Directly below the eaves of the roof is arranged a series of windows which give light to the whole interior of the holder. On the outside there are galleries at convenient intervals with interconnecting ladders giving access to the roof. Inside the holder there is a movable disc or "piston," as it is more usually called, which is rigidly braced and is guided by rollers in its upward and downward travel. A folding ladder gives access from the roof to the top of the piston.

As Fig. 5 shows, the outside edge of the piston is constructed to form a tar seal. Flexible rubbing bars, corresponding in length to each side of the polygonal holder, slide over the inner surfaces of the shell. By means of attached levers and counterweights continuous contact is ensured. The flexibility of the joint is maintained by means of a special fabric inserted between the rubbing bar and the piston structure, in such a manner as to be relieved of any stresses on the piston or pressure on the rubbing bars.

The Southall holder is a 22-sided polygon, measuring 203ft. 6in. over the corners with a height of 279ft. to the eaves of the roof. The total weight of steel in it is approximately 2400 tons. The sectional steel was supplied by Bolckow, Vaughan and Co., Ltd., the Frodingham Iron and Steel Company, Ltd., and the Earl of Dudley's Round Oak Works, Ltd.; whilst the steel plates were obtained from the Park Gate Iron and Steel Company, Ltd., the Appleby Iron Company, Ltd., and Bolckow, Vaughan and Co., Ltd. The piston and the bottom plates are all $\frac{1}{4}$ in. thickness, while the flanged side plates have a thickness of 7 B.G. About 75 tons of special tar are required for sealing purposes, and 584 tons of concrete blocks are needed for loading the piston to give the normal working pressure.

Method of Erection.—Fig. 6 is a half-section and part elevation of a waterless holder similar to that at Southall, but designed for erection upon an elevated foundation; whereas the Southall holder is erected on a normal foundation at ground level. A particularly ingenious method of erection is adopted, and a short description of this method with the special tackle employed may be of interest to our readers.

The bottom plating, roof, and piston are built up and completed practically at ground level. Fig. 2 shows the holder in an early state of erection with the piston and the roof nearing completion. The erection of the special tackle forms the next step. The most important item is the strut known as the "elephant," which is placed between the upper piston bracing and the roof. The "elephant" serves to tie the piston and roof together, and, as shown in Fig. 4, it is also fitted with a pivoted pawl plate, with corresponding ratchet plates clamped to the columns. Compressed air is forced under the piston which rises, carrying the roof and tackle with it, until the pawl plate is brought above the ratchet plate. The supply of air is then cut off and the piston gradually sinks until it rests upon the pawl and ratchet plates. The process is repeated

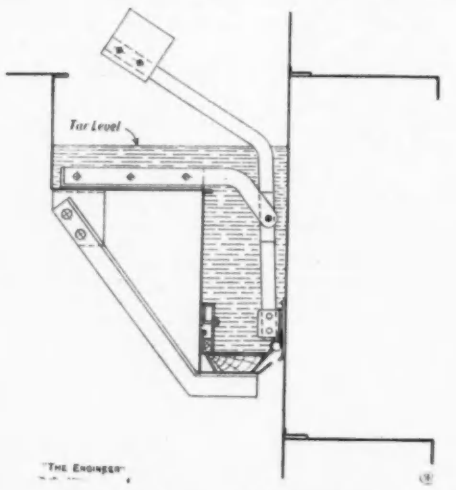


FIG. 5—TAR SEALING ARRANGEMENT

after the erection of each tier of side plates; additional lengths of column being inserted as required.

The erection scaffolding consists of two complete platforms around the holder, which are suspended from the piston bracing, and are, as already mentioned, "blown up" with the piston, so that they are always in the correct position for use. The upper platform is used for the erection of the shell plates, while the lower platform is utilised for riveting. The two operations can then proceed simultaneously, enabling rapid erection to be carried out. An interesting feature of the double scaffolding, which is illustrated in Figs. 1 and 3, is the lower erection platform which is hinged along its outer edge. After erection of each of the galleries, which, as shown in Fig. 1, are placed at intervals up the holder shell, the lower platform was dropped, as will be clearly seen in Fig. 3, so as to hang vertically on its hinges. In this position the platform clears the gallery during the operation of "blowing up,"

after which it is returned to its original horizontal position. In order to facilitate rapid erection, a special pneumatic gap riveter was employed. It consisted of a self-contained riveter and holder-up operated by one man, and is designed to deal with from 3000 to 3500 rivets per day of eight hours. An ingenious roof crane was also used, by means of which all material was simultaneously lifted and luffed into position.

The construction and erection of the Southall holder was carried out by R. and J. Dempster, Ltd., of Manchester. Erection was begun in September, 1928, and the contract was completed in a little over twelve months, which, we are told, is very favourable, compared with the time which would be required for the erection of a telescopic holder of the same capacity. Messrs. Dempster have installed at their works special bending and milling machines for shaping the plates and columns of waterless holders.

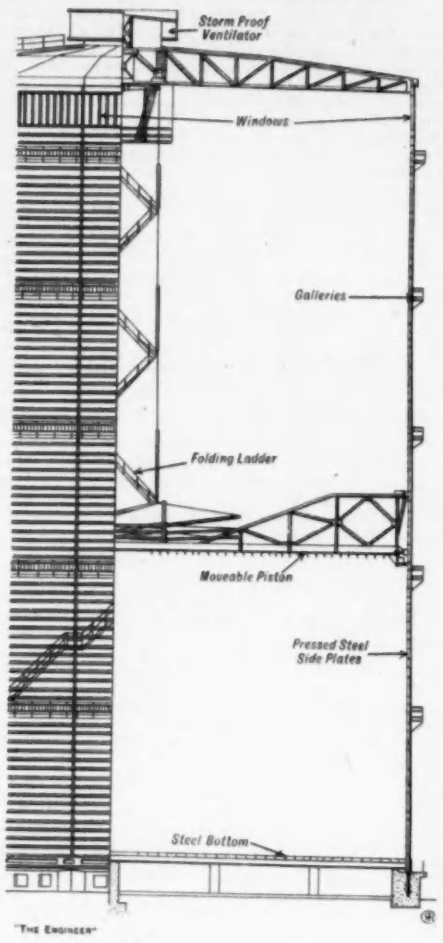


FIG. 6—HALF-SECTION THROUGH HOLDER

Industrial Research.*

WITH certain well-known exceptions, industrial research in Britain did not receive much serious attention until the close of the war. The average age of research departments either belonging to the State or to private companies is certainly less than twenty-five years. Therefore we are really dealing with a movement that is in its infancy.

You will find as I go on this evening that the main stress is laid upon the spirit in which research is conducted. In a way, I am a representative of one of the greatest research-employing industries of the country, but it is hardly fair at the moment to compare the condition of research in the chemical industry with that of any others. The chemical industry during the last ten years has undergone the greatest expansion in its history, and one which is by no means yet completed. This expansion has necessitated the prosecution of research upon an enormous scale, and it is certain that without such continuous large-scale research no progress would have been possible.

I propose, therefore, to deal with the question of research not as confined to the chemical industry, but as applicable to the general industries of the country as a whole. Industrial research had not too good a start as regards the mutual relationships of the parties concerned. Let us begin with the manufacturer who, after all, is one of the principal parties concerned, since it is he who has to pay for it. Manufacturers in this country have had a most anxious and uneasy time during the past seven or eight years, and there has been far too much general condemnation of the manufactuers' attitude to research. The word "backward" is constantly used. The approach to the manufacturer has not been correctly made. He has been urged to prosecute research merely on a paying basis, but I must insist that there is a great necessity for an almost paradoxical frame of mind in this connection.

Let us now consider the second and very important party, namely, the technical staff. The technical staff of an old-established industry will nearly always be what are known as practical men, and their attitude of mind, without being hostile to research or to the scientific worker, is apt to be acutely critical, often for very good reasons.

The research worker has advanced upon industry in the style of Joshua blowing his trumpet, with the negative effect that the walls have not fallen over. Also the imposition of the cost of research upon the cost of manufacture is nearly always one which is to some extent resented by technical men of affairs. My point is that a great many of these difficulties can be overcome by a spirit of enthusiasm in intelligent scientific work. It must always be remembered that if you can convince the manager of a works that he has at his call a body of research workers who are actively and energetically investigating the inmost theories of their subject, you can very often command results which will convert him from a sceptic into an enthusiast.

As regards the research worker himself, I must say that in some cases the scientific man has approached the problems of industry in an altogether too light-hearted spirit. One of the most important things in industrial research is the attitude of mind of the research worker.

Let us then consider the position of any industry which up to the present has had very little assistance from research or has been averse from spending money on research on the grounds of financial stringency.

First, it should be stated, however, that there is strong logical reason against doing research by trades, and that it is probable that some time in the future, research will not be effected by trades, but by the various sections of science into which all the trades concerned will fit. It may well happen that certain trades have very little to gain by research, not sufficient to justify the founding of an adequate research department, because it is impossible to overstress the truth that if research is inadequate it had far better not be undertaken at all. Results will be generally disappointing, and, what is worse, a half-hearted spirit will prevail.

Returning to our industry, which is about to undertake research, we will assume that there are reasonable grounds for hope of improvement. This brings us to the crux. Research in an industry of this character—it must be remembered that by far the greater part of the industries of the country comes into this category—must be on the lines of finding out more about it and especially about the scientific mechanism of its processes rather than an attack on particular difficulties.

This conception demands the utmost open-mindedness, sympathy, and co-operation between the manufacturer on the one hand, and his technical staff and his research workers on the other. This can best be appreciated by looking into that most important question, the condition of the minds of those actually engaged in doing research. Nearly every scientist or scientific worker has in his inmost heart a tremendous respect for the purely scientific and academic sides of his profession. It is also in this sense a regrettable fact that in many cases academic science does not always accord quite that amount of admiration and understanding to industrial science which is necessary in order for it to maintain its self-respect.

When we examine the various statements made by great scientists and the facts of the conditions under which they worked, we find that independence of work and thought is the characteristic upon which they would most insist. If your research workers are always worried as to the production of what are called results, you will inevitably destroy that free play of mind which is so essential for the very difficult task of achieving the further development of an old-established industry.

I am seriously suggesting to you that the key to successful industrial research will be found in the development of the individual scientific enthusiasm of your research worker. There is all the difference in the world between a man who is filled with a kind of glorious obsession in his work and a man who is merely doing work in order to obtain a living. In many cases the conditions of an industry are such that it is nearly impossible for them to pay their scientific workers really adequately, even if they cared to do so. I do not propose to elaborate that question, but I wish to impress upon you that a man must have some driving force behind him if he is to do good work. Monetary success is a tremendous incentive, but if you cannot get this, there is only one other thing possible, and that is the stimulation of enthusiasm among your scientific workers by every means in your power.

The research worker, like all of us, is subject to various cross currents of thought. A new phenomenon is arising; people are taking up industrial research as a means of livelihood. People are constantly asking me whether they shall make their son a physicist, a chemist, or an engineer—the answer being supposed to be predetermined by that profession in which he has the biggest chance of making a large income. This outlook produces a cross current in the mind of the scientific worker, which is very apt to lead him towards the executive administrational sides of the business.

Claud Bernard, the famous French physiologist, in a striking passage emphasises the necessity of performing experiments without preconceived ideas. Many men whose whole lives and reputations have been connected with pure science have failed in this respect. How much more difficult is it, therefore, for the industrial research worker. Let us consider an average case of the training and environment of such a man. Nearly always he has been to a university, where, in order to obtain a good degree, it is necessary for him to cram like the proverbial Strassbourg goose. He next settles down for one or two years of research in the university of which he is already a member, though I consider that there is nothing more admirable for a man who has gained his degree at a university than to do his research somewhere else. During the two years' research our young man is at the mercy of another cross current. Usually the research which he undertakes has not been suggested by himself, but is part of a general scheme worked out by the professor to whom he is responsible. The latter is under a kind of moral obligation to suggest a theme which will, as they say "come out"—that is to say, which will yield some sort of result. This obviously means that very many of the interesting and more difficult ideas of science are neglected.

Another cross current is provided by changes of fashion, for you must remember that science runs in fashions. At the moment, what you might call the fashionable theoretical trend is not particularly of immediate advantage to industry. I am not attempting to decry in the slightest the magnificent achievements of modern theoretical science; nevertheless, a great deal of modern chemistry and physics is remote from what you might call practical life.

All this may sound a little depressing; but, in fact, it is not so. I have outlined the chief dangers merely to prove that if you recognise them they are the more easily overcome. Here are a few random suggestions. Research workers ought to travel and consult with other people a great deal more than they do at present, if only to prevent the almost endemic disease of mental staleness. The travelling accounts of many research associations are ludicrously small. A great deal also can be done by close association of trades which have nothing to fear from each other. Of course, there has been in this country a kind of what might be called jealousy in the past; for instance, of the necessity for secrecy. There are at this moment many research departments in different trades which could exchange complete information and mutual visits of staffs to the greatest good of everybody. It is also of the greatest value to stimulate and encourage friendly international relationships between scientific workers. Such exchange, and I have had a good deal of experience of it, is nearly always mutual, and its effect on industrial scientific workers is of the very greatest good.

* An address by Dr. F. A. Freeth, F.R.S., Joint Research Manager for Imperial Chemical Industries, Ltd., on Friday, November 1st, to the annual joint meeting of the Society of Chemical Industry, the Institute of Chemistry, the Society of Dyers and Colourists (Manchester Section), and the Manchester Literary and Philosophical Society. Abstract.

American Engineering News.

Aluminium for Structural Work.

THE rapidly widening uses of aluminium include bridge and crane girders, rolled joists and shapes, and castings of great size for locomotives, railway cars and tramcars. Many of the smaller structural parts are made by extrusion, but all the larger sections are rolled. Riveting is done with hot steel rivets in the usual way, except that alternate holes are first riveted and then the intermediate holes, in order not to localise the heat, and thus affect the properties given by heat treatment. Welding is not used where the sections are highly stressed, as the weld metal is of a cast structure, and is not as strong as the rolled material. In some large "skyscraper" office buildings, the spandrels are large ornamental panels of cast aluminium. Window sills of the same material are also used. A new blooming mill now being built will handle ingots, 20in. by 22in. in section and 6ft. long, weighing about 3000 lb. However, for rolling slabs for plates, the rolls can be spread to admit billets 36in. thick. Adjacent to this is the rolling mill, with three three-high stands and one two-high stand, all with 28in. rolls. The blooming mill has a capacity of 500 tons daily and the rolling mill 250 tons daily. After rolling the aluminium shapes they require heat treatment, and are delivered to a furnace, through which they pass on rollers, and as they emerge they are led through a quenching spray of water. Some alloys are then ready for use, except for occasional straightening. For other alloys, it is necessary to deliver the shapes to a steam chamber for ageing, after which the final straightening is done. The 10-ton 72ft. travelling cranes in the shops have aluminium bridge girders.

Power Penstock for 2418ft. Head.

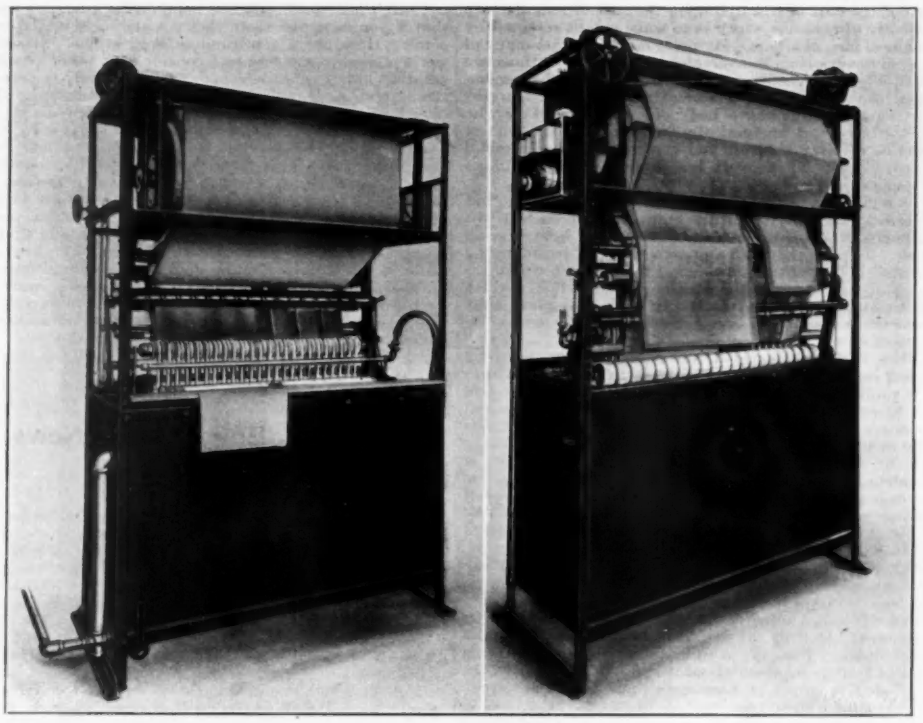
The Big Creek hydro-electric station of the Southern California Power Company is served by a pipe line or penstock, 6665ft. long, having a static head of 2418ft. For 1858ft. from the top it consists of riveted steel pipe, beginning at 9ft. diameter and reducing to 7ft. For the next stretch of 3043ft. it is of forge welded pipe reinforced with seamless forged steel bands. Here the diameter begins at 7ft., and reduces to 5½ft. For the lower stretch of 1764ft. there is seamless forged pipe, 5½ft. in diameter. The quadruple riveted pipe has a thickness of $\frac{3}{8}$in. at the top and $1\frac{1}{16}$in. at the lower end. The banded pipe has the bands machined on the inside, and they are spaced at distances about equal to their width while the pipe itself is 1¼in. thick at the upper end and 2¼in. at the lower end. In the seamless forged pipe the thickness begins at 2¼in. and increases to 3in. From its lower end two 48in. pipes diverge, each again diverging into two 36in. pipes, which lead to the two jet wheels on a generator shaft. The seamless forged steel pipes are 25ft. to 30ft. long, and weigh about 25 tons each. They are flanged for bolted joints, the flanges being grooved to receive india-rubber gaskets, ¼in. in diameter. They are made from solid cast steel ingots, 7½ft. in diameter. In tests to destruction a forged seamless pipe, 5½ft. in diameter and 3in. thick, failed at a pressure of 5300 lb., while a banded pipe of the same size and 2¼in. thick, failed at 3930 lb. test pressure.

Air Rights Developments.

With the considerable area of valuable land occupied in large cities by railway stations and facilities, and the increasing necessity of enlarging railway revenues to compensate for losses due to traffic diversion and heavy taxation, there is an increasing tendency to utilise the air rights or space above the railway property for revenue purposes. Perhaps the most extensive development of this new policy is at New York, where the property occupied by tracks and approaches to the terminus of the New York Central Railroad is now surrmounted by lofty hotels and office buildings. At Chicago, two of the termini have tall buildings for offices—used largely by the railway companies, while others have low buildings exclusively for station purposes. None of them as yet have tall structures over the track and platform space or the approaches, except that a portion of the 23-storey *Daily News* building extends over the approach to the Union Station. There the position of columns and girders of the lower floor had to be determined jointly by the engineers for the station and publishing companies in order to provide for the track plan. A large goods station now being built by the Chicago and North-Western Railway is surmounted by a 20-storey warehouse owned by a company to which the railway has sold its "air rights," the warehouse property beginning a height of 23ft. above the railway tracks. The railway occupies two floors, connected by

PHOTO-PRINT WASHER AND DRYER

THE PRECISION PHOTO PRINTING PLANT, LTD., LONDON, ENGINEERS



elevators and separate elevators connect the warehouse floors with the station platforms. The warehouse building is about 324ft. wide and 724ft. long.

Roller Bearings for Railway Cars.

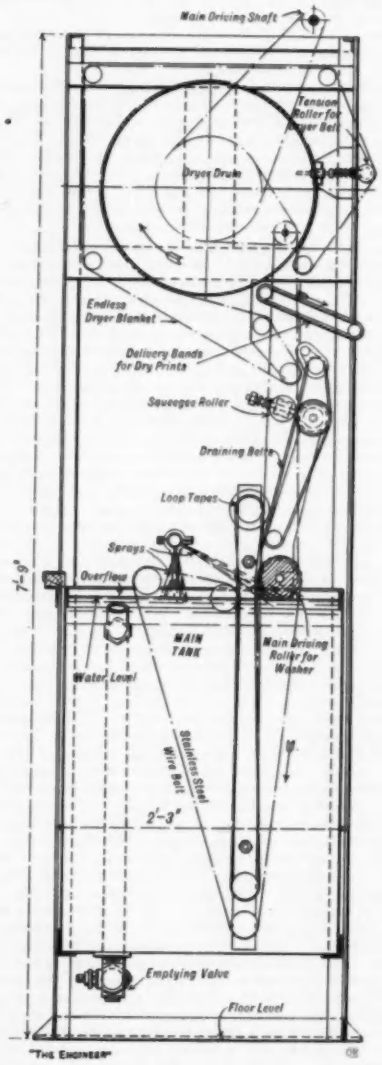
Although the application of roller bearings to the axles of railway carriages and wagons in the United States is of quite recent date, except for experimental purposes, there are now about 1600 passenger cars equipped and 475 steam, petrol, and electric locomotives, while miscellaneous rolling stock brings the total to nearly 2100 vehicles. Some of the bearings have been in continuous use for about 500,000 and 800,000 miles run, and are still in service. In some cases there has been trouble brought about by improper or insufficient lubrication. The application of such bearings to goods cars on a practical or commercial scale is improbable, on account of the short proportion of their time which these cars spend in running on the rails. In winter service the bearings have proved entirely satisfactory, but further study of the best materials and methods for lubricating roller bearings must be carried on. In this connection it is very desirable to increase the life mileage of wheels, since changing of wheels is likely to result in damage to the bearings. In ordinary service some test bearings have been running for nine years without showing appreciable wear. The service on different railways includes both main line and suburban traffic, with both steam and electric locomotives. A large locomotive now being built has roller bearings on all engine and tender axles, and also on the connecting and coupling-rods.

A New Washer-Dryer for Photo-Prints.

THE washing and drying machine for blue-prints, which we illustrate above, is a development of a rather similar apparatus which we described in THE ENGINEER of February 16th, 1923, and May 8th, 1925. It is made by Precision Photo Printing Plant, Ltd., of Salisbury House, London, E.C. 2, and is characterised by the fact that after the prints have been fed in, and they may be fed in in any way, so long as they do not overlap one another, they require no attention until they are delivered dry ready for delivery.

In the original machine, it will be remembered, the various parts were arranged, more or less, in a horizontal plane, with the result that the apparatus occupied a considerable amount of floor space. This disadvantage enforced itself on the minds of the inventors so much that they set to work to devise an arrangement in which floor space would be saved by setting one part of the machine above the other. That is to say, by standing the machine on end. The difficulty then arose, however, of elevating the print from the first process of washing to the drying drum above without manual control. This problem has been successfully overcome by the employment of a series of rubber bands.

On reference to the drawing it will be seen that the main washing tank forms the base of the machine. Into it the prints are drawn by a wide belt of wire mesh. This belt, like its predecessors, is so woven that it presents a flat surface for the reception of the print; but it is now made of stainless steel instead of bronze. Towards the front of the machine this belt runs over two rollers, above the water level, to provide an approximately horizontal part for the reception of the print. Immediately above there is a perforated pipe, which sprays the print with water. The print is then dragged down to the bottom of the tank and up again, between the wire belt and a series of vertical tapes running round separate rollers. It is usual to put some bichromate of potash in the bottom of the tank, to help in developing the print, but it does not seem to get stirred up into the general body of the water, no doubt on account of its high specific gravity,



SECTION THROUGH PRINT WASHER-DRYER

so that as the print emerges from the tank it is thoroughly washed.

Some backwardly diverted jets from the spray pipe pass right through the vertical tapes and give the print a bias towards a set of rubber belts that travel upwards in a nearly vertical direction. The wet print naturally clings to these belts and as it is drawn upwards most of the water drains off its surfaces. It is, however, passed between two bronze squeegee rollers, which are held together by springs, to squeeze out as much moisture as possible. Little spring steel fingers ensure that the paper does not wrap itself round the rollers. The print is then guided by other rubber bands on to a canvas blanket, which is wrapped round a rotary drying drum at the top of the machine. This drum is heated electrically, and on emerging the prints are quite dry and ready for issuing. They are guided by a short conveyor on to a table, or any other convenient receptacle at the back of the machine. The whole machine is worked by a small electric motor, arranged on the top of the framing, which drives the dryer drum through a hand and worm gearing. There is a chain drive to the main roller of the wire, washing, belt, and the rubber bands of the several conveyors transmit the drive from one roll to another. The linear speed of the dryer drum is arranged to be slightly greater than that of the washing sections, so that there shall be no possibility of congestion.

The machine is, as will be gathered from the engravings, substantially built, and is what might be described as an engineer's job. It is capable of handling four hundred Imperial prints per hour. We have tried it with many kinds of paper, from the stoutest blue-print down to the cheapest newsprint, and with blue-print linen, and found it equally effective in all cases. It did not matter whether the prints were put in square or not, they went right through the machine without puckering, and they came out with so little shrinkage that they could be scaled off.

B.E.S.A. Specifications.

STEAM TURBINES FOR ELECTRICAL PLANT.

THE British Engineering Standards Association has recently issued B.S. Specification No. 132–1930, Steam Turbines, which is a revision of the 1920 edition, and has been in preparation for several years, the work having been carried out in parallel with the International Specification for Steam Turbines by the International Electrotechnical Commission. It is interesting to note that so close has been the co-operation between the British and the International Committees that the new specification is, to all intents and purposes, identical with the International Specification upon which the I.E.C. Advisory Committee tentatively agreed at the meeting in London in July last.

It is also of interest to note that, whereas the 1920 edition of the specification was confined to steam turbines for electrical plant, the new specification is not so restricted.

Considerable attention has been paid by the Committee responsible for this specification to the list of recommended standard ratings, an endeavour having been made to limit the standard sizes to the fewest possible number. In this matter the Committee has had the advantage of the close co-operation of the Electricity Commissioners, in so far as home requirements are concerned, the result being that the list of standard ratings, although given only as a recommendation, represents a thoroughly practical series of sizes for home and export purposes.

TARS FOR ROAD PURPOSES.

The British Engineering Standards Association has now issued a revised British Standard Specification for Tars (Nos. 1 and 2) for Road Purposes, which represents a considerable advance upon the Ministry of Transport (Roads Department) specifications issued as British Standard Specifications in April, 1928. This specification has been prepared by the British Road Tar Association, and having been considered and approved with slight modifications, is now issued by the British Engineering Standards Association as a British Standard Specification, and has the full support of the Ministry of Transport. It covers, as formerly, tar for the surface tarring of roads and for making tarmacadam. The methods of testing and specifications for apparatus contained in appendices have been specially prepared by the Standardisation of Tar Products Test Committee. They provide for the determination of every property of the tar covered by the specification, and are prescribed in much greater detail than in the Specification No. 76–Part 1, 1928, now superseded.

ALUMINIUM AND STEEL-CORED ALUMINIUM CONDUCTORS.

A specification, No. 215–1930, just issued by the British Engineering Standards Association, is a revision of the 1925 edition, and differs from its predecessor mainly in that the value of the resistivity has been slightly altered in order to conform to the value recently adopted by the International Electro-technical Commission. The tables given in the specification have been recalculated in accordance with the new value of the resistivity. Provision has also been made for certain of the mechanical tests to be carried out, both before and after stranding. Slight modifications have also been made in the galvanising test.

Copies of all these specifications may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria-street, S.W. 1, price 2s. 2d. each post free.

A PLAN of research for 1930 to investigate the industrial applications of tin and discover new and improved uses for the metal has been announced by the Industrial Application Committee, which is working in conjunction with the British Non-Ferrous Metals Research Association. The most important lines of research will be: To investigate the non-corrosive qualities of tin in relation to other metals with a view to establishing scientific data as to its industrial value; to investigate improved methods of alloying tin to steel plates with a view to broadening the market for canning of foods; to investigate the value of tin in relation to the lubrication of high-speed machinery, and to establish the non-toxic qualities of tin as the safest metal to be in contact with milk and other foods.

Elimination of Noxious Gases.

IT is reported from Baltimore that a means to eliminate the carbon monoxide, which is a poisonous constituent of the exhaust gases from motor car engines, has been discovered by Dr. J. C. W. Frazer, Chairman of the Department of Chemistry of Johns Hopkins University, and Mr. B. N. Baker, Professor of Chemistry, at the same university. Dr. Frazer, it is announced, states that tests have demonstrated that a motor car equipped with the newly discovered agency can be left indefinitely in a closed garage with the engine running without liberating carbon monoxide or any other poisonous gas.

Carbon monoxide is produced by the incomplete combustion of fuel in the motor. Dr. Frazer's discovery is a catalyst, in the presence of which the carbon monoxide gas of the exhaust is completely burned to form carbon dioxide. Air is mixed with the exhaust gases from the engine, and the mixture is led over a bed of the catalyst. The catalyst is of such a nature that, in addition to changing carbon monoxide into carbon dioxide, it burns all exhaust residue, including the offensive odours common to city streets and entirely consumes all smoke.

The present discovery is, to a certain extent, the result of work carried out during the war by Dr. Frazer and his laboratory staff for the Chemical Warfare Service. The necessity for protecting men operating guns in closed turrets from the carbon monoxide gas produced during firing, led to the development of a catalyst to be used in gunners' gas masks. The catalyst devised for that purpose was very effective, and is still used by the United States Navy. It is also a useful protection to persons whose duties compel them to remain where the gas has an opportunity to form. More recently, the U.S. Bureau of Mines and the Mines Safety Appliances Company of Pittsburgh, have adapted it for use in mines in accident prevention and rescue work, while the fire departments of most cities use it as part of their regular equipment.

But the catalyst which proved successful in gas masks was incapable of being employed under the conditions imposed by direct contact with hot motor vehicle gases, and, after working on the problem for the last two years, Dr. Frazer claims to have produced a catalyst which differs radically from those previously employed. Laboratory as well as short and long road tests have been made with a motor using the catalyst under most diverse driving conditions. Tests have also been conducted in confined spaces simulating closed garages. Dr. Frazer says that the catalyst has been found effective in all these tests, and there is no doubt that a possible means has been found to eliminate a cause of fatal accidents as well as a course of discomfort and impaired vitality for those compelled to breathe atmospheres polluted by gas engine exhausts. It is understood that patent protection has been applied for.

To adapt the discovery to practical automobile use, however, requires, apparently, the perfection of a simple and efficient mechanical device to carry the catalyst in such manner that the exhaust gases are exposed to its action. That, Dr. Frazer says, is a problem which from present indications can be solved. It is now in the hands of experts who have already produced a reliable device, but one which must be further simplified. Furthermore, the heat generated in the catalytic oxidation of the noxious gases offers opportunities for better utilisation of the heat value of the fuels used. That aspect will also form a subject for further research.

CALENDARS, DIARIES, &c.

J. AND H. MCLAREN, Ltd., Leeds.—Wall calendar with monthly tear-off slips.

MOSS GEAR COMPANY, Ltd., Crown Works, Tyburn, Birmingham.—Wall calendar with monthly tear-off slips.

L. F. NORRIE AND CO., 30, South Fort-street, Bonnington, Edinburgh.—Wall calendar with monthly tear-off slips.

PECKETT AND SONS, Ltd., Bristol.—Wall calendar with monthly tear-off slips.

PRIEST FURNACES, Ltd., 123, Albert-road, Middlesbrough.—Refill for desk calendar.

TANGENT TOOL ENGINEERING COMPANY, Ltd., Tangent Works, Keynsham, near Bristol.—Desk calendar with daily tear-off slips.

URQUHART, LINDSAY AND ROBERTSON ORCHAR, Ltd., Blackness Foundry, Dundee.—Wall calendar with monthly tear-off slips.

ROYAL AIR FORCE: AIRCRAFT APPRENTICES.—The Air Ministry has announced that six hundred aircraft apprentices, between the ages of 15 and 17, are required by the Royal Air Force for entry into the Schools of Technical Training at Halton, Bucks., and at Cranwell, near Sleaford, Lincs. They will be enlisted as the result of an open competition and of a limited competition which will be held in the near future by the Civil Service Commissioners and the Air Ministry respectively. Successful candidates will be required to complete a period of twelve years' regular Air Force service from the age of 18, in addition to the training period. At the age of 30 they may return to civil life, or may be permitted to re-engage to complete time for pension. Full information regarding the dates of the respective examinations, the methods of entry and the aircraft apprentice scheme generally can be obtained upon application to the Royal Air Force (Aircraft Apprentices' Dept.), Gwydyr House, Whitehall, London, S.W. 1. The sons of officers, warrant officers and senior N.C.O.'s of the three Services will receive special consideration.

ARTICULATED LOCOMOTIVES.—Before the Graduates' Section of the North-western Branch of the Institution of Mechanical Engineers a paper on articulated locomotives was read on Thursday, 16th inst., by Mr. D. R. Carling, B.A. (Cantab.), Captain H. P. M. Beames presiding. In the paper the author gave a very clear description of the different types of fully articulated locomotives, such as the "Fairlie," the "Meyer" and the "Garratt." The advantages and disadvantages were discussed at some length, and the results of tests carried out in service were given. The author said that there were now in use in various parts of the world about 500 articulated engines of the "Garratt" pattern, some of which weighed well over 200 tons in working order. Mr. Carling said the economics of this type of locomotive were too important to neglect. In most cases the employment of them was a better solution of the main line traffic haulage problem than electrification. Some of the examples of "Garratt" engines built for very narrow gauge railways were remarkable for the flexibility and great hauling power which was concentrated into the limited space. The paper was illustrated by a large number of lantern slides.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Quiet Tone.

INDUSTRY in the Midlands and Staffordshire appears to be taking longer than usual this year to get into its stride. Many of the works have unemployed plant and workmen "stood off." On the iron and steel market a quiet tone exists and this week's gathering on 'Change in Birmingham produced but few orders. The attendance was not large, and activities were limited to small-scale business. Nothing has occurred during the week to clarify industrial prospects, and producers and consumers of iron and steel are alike to some extent working in the dark. There is an evident want of confidence which deters manufacturers from going ahead with the programmes which they had mapped out for this year. This, of course, means that iron and steel and other materials which should by now be finding its way into the works remains unordered. Were the horizon less obscure, an appreciable volume of trade would, it is believed, be available to Midland industrialists.

Pig Iron.

The position has changed somewhat in the pig iron market in the Midlands, and users are less apprehensive of a further price advance as a result of the meeting of the Association controlling prices, which is to be held before the end of the month. A week or so ago there seemed every probability of another rise in raw iron prices; to-day, a large element of uncertainty exists. The stringency which has existed for some little time in the foundry iron branch now appears to have disappeared, and output is about equal to demand. Northamptonshire blast-furnace men, in particular, are finding buyers holding off the market, and their order books which have until recently been very well filled are not being maintained at such a satisfactory level. Derbyshire blast-furnacemen find less inclination on the part of pig iron consumers to pay premiums over the recognised selling levels to ensure forward supplies. Moreover, work at the foundries is less brisk. Some relaxation of the tension in the coke market has taken place, and odd lots of furnace coke have been obtained on terms below the current market price. The price asked by ovenmen to-day is 18s. to 18s. 6d. per ton. The Midland output of foundry pig is being immediately absorbed, but forge iron, owing to the poor demand from Black Country ironworks, is accumulating.

Steel.

In the heavy steel trade business remains quiet, while there has been some falling away in the half products branch. The position in the industry as a whole in this district is, therefore, at the moment, not so good as it was. The outlook, however, as stated last week, is improving, and the setback should be of a temporary character. There is reported to be a fair volume of work at the constructional engineering yards in the Midlands, though it relates chiefly to small tonnages. Buying of angles, joists, and plates is confined to narrow limits, engineers having anticipated and covered forward requirements. Special steels for use by motor engineers are in fair demand, and specifications against contracts in this department are growing in size. Staffordshire hoops sell moderately at £10 per ton at makers' works. Angles are £8 7s. 6d., tees £9 7s. 6d., joists £8 10s., ship, bridge and tank plates £8 17s. 6d.—all subject to rebate. Boiler plates command £9 12s. 6d. upwards. Re-rollers of small bars have some difficulty in maintaining selling prices at £8 2s. 6d., but they continue to quote that figure. New buying of continental material is comparatively quiet. Merchants and shippers, up to now, have adhered to the minimum rates fixed by the Cartel for billets and steel bars. For billets £5 10s. is quoted against the English makers' price of £6 5s. and Welsh makers' figure of £6 2s. 6d. Sheet bars from the Continent cost £4 12s. f.o.b. Antwerp, but the galvanised sheet trade is so depressed that little material, either English or foreign, is being bought.

Finished Iron.

Steady and regular business is being experienced by Staffordshire ironmasters who have no difficulty in disposing of their output of marked bars at the recognised level of £12 10s. per ton. Much more work is needed in the Crown bar department, where selling prices remain in the same liquid state which has prevailed for some time past. The additional activity at the shipyards has not up to now created a revival in demand for chain and anchor iron. Belgium firms still take the bulk of the business in the common bar branch of the trade. No. 3 iron is obtainable from the Continent at £6 5s. to £6 7s. 6d. delivered here, whereas local makers ask £9 to £9 5s. The Darlaston nut and bolt works are reasonably well employed, but Staffordshire material forms a very small percentage of the raw material now used in these establishments. Not quite so much is being done in wrought iron tube strip, but values are maintained at £11 2s. 6d per ton. Tube works are slightly less active, and, moreover, many of them are well bought and will require little additional strip this quarter.

Galvanised Sheets.

Makers of galvanised sheets have this week failed to maintain prices of 24 gauge corrugateds, even at the low level at which they stood a week ago. Keen competition in a very unresponsive market brought about a further fall in values, ranging from half a crown to 5s. per ton. Whereas a week ago £12 5s. appeared to be the lowest level acceptable, mills now freely offer supplies at £12 2s. 6d., some being prepared to go even lower, to £12 per ton f.o.b. Not the slightest improvement in demand is discernible, and mills are becoming extremely "hard up" for work. Mills in this area are, however, slightly better placed, and most of those in other areas.

Scrap.

Business continues slow in scrap, and Birmingham merchants are far from satisfied with the immediate prospects. Prices are as a week ago, £3 6s. to £3 7s. 6d. per ton for heavy steel scrap delivered South Wales.

Midland Foundry Trades.

A thoughtful commendation of the value of the interchange of knowledge in various industries and arts was given by Alderman Byng Kenrick, Deputy Lord Mayor of Birmingham, speaking on Saturday at the annual dinner of the Birmingham, Coventry and West Midland Branch of the Institute of British Foundrymen. He said that it was only with the passing of the nineteenth century and its traditions that we began to see the establishment of associations of those interested in a trade definitely started with the idea of what our ancestors would have called "swopping trade secrets," a thing that would have been considered inconceivable. The change shows the development of a more enlightened mind in industry. In the last twenty-five years, said the speaker, there had been very great developments in the foundry trade, both as regards metals used and their combination, and progress would not have been nearly so rapid if the members had not been willing to come together from time to time and pool their experiences. In that way they had not only benefited themselves, but the nation as a whole. As far as equipment and technique were concerned, the Institute was equal to any association of foundrymen in the world. Mr. Wesley Lambert, President of the Institute, recalled that the Institute was founded in Birmingham. It now had an active membership of 2000. It was stated by Mr. E. H. Tyson, Branch President, that the branch continued to thrive.

Midland Structural Engineers.

The Midland Counties Branch of the Institution of Structural Engineers, held its fourth annual dinner in Birmingham on Saturday last under the presidency of Mr. D. G. Mackintosh. In the course of the speeches Mr. Robert Green, Chairman of the Birmingham and District Association of the Institution of Civil Engineers, spoke of the growth of the Structural Engineers' Institution and its development, and pointed out that its present membership was 3500. Lieut.-Colonel J. Mitchell Moncrieff, the President, referred to the important place occupied by the structural engineer in the realm of engineering. During the evening the Bronze Medal of the Institution and the L. Lister-Kaye Award were presented to Mr. A. W. Legat for his paper on Design and Construction of Buildings in Reinforced Concrete; and the L. Lister-Kaye Award was also presented to Mr. H. W. Coultas for his paper on Experimental Structural Engineering, with special reference to the Mechanical Solution of Indeterminate Structure.

Inadequate Canal Bridges.

At a meeting on Tuesday of the Association of Midland Local Authorities, representing over forty bodies, the urgency and importance of the need for strengthening and reconstruction of weak bridges over railways and canals was emphasised by Sir Henry Maybury, the Consulting Engineer on Roads and Transport to the Ministry of Transport. Sir Henry's address ought to hasten the removal of a serious hindrance to transport and trade in Warwickshire, Staffordshire and Worcestershire. He announced that the Government will make a grant to local authorities of 75 per cent. towards the cost of approved schemes for the betterment of bridges. On two points, he said, authorities could be quite certain: the Ministry of Transport wants necessary work of bridges to be put in hand at the earliest possible date, and it will pay 75 per cent. of the cost. In the area of the local authorities around Birmingham there are 294 canal bridges which are inadequate for present-day traffic, and at least 109 of them are on classified roads. Action is being now taken with respect of forty-four of the bridges. As to weak railway bridges, thirty-five are inadequate, and of them, twenty are on classified roads. The local authorities contemplate action in respect of five. The Ministry was desirous, Sir Henry said, that very substantial orders should be placed from the Birmingham district for steel girders in connection with the reconstruction of bridges, now that the way had been made easy for local authorities.

Birmingham's £2,000,000 Relief Schemes.

Schemes of work for the relief of unemployment, approved in principle, and now awaiting the approval of the Birmingham City Council, are estimated to cost £2,092,996. The works proposed are—Road works, £1,054,783; bridges, £41,763; sewerage works, £527,550; river improvement, £405,000; and public parks, £63,900.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Textile Machinery's Slight Gain.

HOPES of the exports of textile machinery last year touching the £12,000,000 mark have not been realised, largely owing to several disappointing months, including December, but the net result is a slight improvement over 1928, though a decline compared with 1927, the respective totals for the three years being £11,643,902, £11,623,480 and £11,739,232. Last year's value included 99,150 tons of spinning and twisting machinery, valued at £8,969,031, and 20,937 tons of weaving machinery, valued at £1,703,438. Several markets, notably British India, France, China, Japan, the United States and Australia, took appreciably more British plant of this class, but the improvement in these directions was only just sufficient to offset the reduced shipments to Russia, Germany, the Netherlands, South America and "other European countries." British India continues to be responsible for much the biggest share of the trade,

last year's exports to this market reaching a value of £3,019,000. Japan was second with £1,040,000, followed by France with £809,000, China £736,000, Russia £698,592, Germany £630,000, South America £513,000, the United States £507,000, the Netherlands £507,000, and Australia £273,000, "other European countries" in the aggregate taking textile machinery to the value of £2,251,000.

Another Big Locomotive Order.

A further important addition to the order books of Lancashire locomotive engineers is reported this week, a contract for the supply of 20 locomotives and tenders at a contract price of £150,000 having been placed with the Vulcan Foundry Company, Ltd., Newton-le-Willows, by the Central Argentine Railway Company, Ltd. This follows rapidly upon the heels of the order placed last month with Beyer, Peacock and Co., Ltd., Gorton, Manchester, by the London, Midland and Scottish Railway Company. In that case the contract was for 30 heavy freight locomotives of the "Garratt" type at a total cost of about £300,000. These two orders are, of course, of outstanding importance, and, with several smaller ones placed recently with Lancashire firms, have greatly improved the prospects in this branch of engineering.

Obituary.

Mr. John Hall, chairman and governing director of Hall and Pickles, Ltd., iron and steel merchants, Manchester, and chairman of the British Reinforced Concrete Engineering Company, Ltd., and of the Chatwood Safe Company, Ltd., and also for a number of years chairman of the Iron and Steel Stockholders' Association of Lancashire and Yorkshire, died last week end at the age of 59. Under the Ministry of Munitions Mr. Hall, during the war, controlled the production of the British steel works and rolling mills.—Mr. Joseph Foster, senior partner in Messrs. Foster Bros. and Co., constructional engineers, Preston, and a member of the executive committee of the Preston and District Engineers and Iron Founders Employers' Association, died at Preston last week at the age of 73.—The death took place at Hazel Grove, Stockport, on Tuesday of this week, of Mr. W. F. Sowerbutts at the age of 45. Mr. Sowerbutts succeeded the late Mr. S. Meunier as gas engineer for Stockport about twelve months ago, and had been deputy-engineer since 1909.

Non-ferrous Metals.

Taking the non-ferrous metals market as a whole, the demand is by no means extensive, and although there has been no spectacular price movements during the past week and not a great deal of loss on balance, a certain amount of fluctuation has been in evidence. As it has been for some weeks now, the market position of tin continues to be adversely influenced by the steady increase in stocks of the metal in warehouse at British ports, and a further decline in values, largely for this reason, has to be recorded. Compared with a week ago, tin prices are lower to the extent of from £2 to £2 10s. per ton, current values being about £14 per ton below mid-December parities. The copper section has experienced its ups-and-downs, and, on the whole, market movements during the week have chiefly been reactionary. More recently, however, there has been a recovery with prices on balance virtually unchanged compared with a week ago. So far as trade buyers are concerned there is not much confidence in the future of the copper market, and the demand both for standard and refined descriptions of the metal is on cautious lines. Lead has probably been the steadiest section and quotations are pretty well unchanged, with, however, quite sufficient on offer to meet current requirements. Inquiry for spelter has been relatively slow, and plentiful supplies tend to exercise a sagging influence on prices. At the time of writing there has been a recovery from the lowest point touched, and compared with a week ago values are higher to the extent of about 7s. 6d. a ton.

Iron and Steel.

Firm prices and a fair amount of activity have characterised the foundry iron market this week. Lancashire foundries are still placing orders on forward delivery account and are specifying for reasonably good quantities. Under the circumstances, there is no indication of the price position easing, Derbyshire and Staffordshire being at the zone rate of 77s. per ton for delivery equal to Manchester, Scottish at about 95s., and hematite iron at 92s., also delivered here. Lancashire Crown bars are at £10 15s. and seconds quality at £9 15s., but, as before, the demand for these is comparatively slow. Inquiry for steel materials this week has only been moderate, and both in plates and in constructional kinds there is room for improvement, whilst with regard to bars it seems to be only in the case of the bright-drawing qualities that the demand is at all satisfactory. Quotations on this market during the past week have been at from £8 5s. to £8 7s. 6d. per ton for small re-rolled bars, £9 7s. 6d. for large bars, about £10 for acid and basic boiler plates, £8 17s. 6d. for general plates, £8 10s. for joists and £8 7s. 6d. per ton for sections. There has been a rather sharp decline in the price of imported bar iron to about £6 per ton for No. 3 quality, including delivery to buyers' works in this area, but otherwise the market for continental products is fairly steady at the minimum rates fixed by European mills. So far as actual business is concerned, however, they are receiving little encouragement from Lancashire, the demand for finished and "semi" products being of limited aggregate tonnage.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade continues to be satisfactory and makers are, by reason of the contracts they hold at present, in a fairly strong position. Many customers have covered themselves for the next four or five months to assure themselves of supplies. In the special quality branch there is a good steady business and the inquiries are re-assuring. Much of this class of iron is going to the Continent and to America with whom business continues to be fairly good. The iron ore trade is steady. The local demand remains practically the same, and will continue to be so until another furnace is put in blast, which is hardly likely to happen at present. Steady imports of foreign ore continue. The position in the steel trade is not very good, although it is better than it was a few months ago. Both Barrow and Workington are running but not at full strength. The railway material which is being turned out is both on home and foreign account.

Shipbuilding.

The good news which has been hinted at recently in this letter is at last confirmed by the statement that Vickers-Armstrongs are to build two 20,000-ton P. and O. liners at Barrow. This work will mean a considerable relief of unemployment in the district, but it is emphasised that an influx of unemployed from other parts is not required, as there are sufficient skilled and unskilled men available locally to satisfy the labour requirements of 2500 hands for two years. The British Thomson-Houston Company, of Rugby, will construct the turbo-electric installation in collaboration with Vickers-Armstrongs, and Yarrow and Co. will build the special high-pressure boilers for the first ship, those for the second being built at Barrow.

SHEFFIELD.

(From our own Correspondent.)

An Unsatisfactory Opening.

THE condition of many branches of the steel trade leaves much to be desired. The New Year has opened very indifferently, and the general position is worse than that of a year ago. This state of things is not confined to Sheffield, as a similar quietude is to be found in all the other great centres of production. There is apparently much uncertainty as to what may happen in the near future, and cautious buying is the rule everywhere. The number of workpeople suspended in Sheffield at Christmas was considerably larger than in the previous year, and only a small proportion of them have been taken back so far. The heavy steel branches are badly in need of work. There is also a shortage of orders for best tool steels, and some of the finished departments also complain of a falling-off of work.

Stainless Steel for St. Paul's.

There is still much activity in the special branches, the story of which presents the brighter side of the picture. Cold wrought steel, stainless steel, stampings and steel for motor vehicles and aircraft, and supplies for the electrical industry are all good lines. I have more than once referred to the important contributions of stainless steel which Sheffield made for the strengthening of the dome of St. Paul's Cathedral, and in particular have called attention to the two great chains made by Brown Bayley's Steel Works, Ltd. Great assistance was also rendered by Thos. Firth and Sons, who supplied more than 120 tons of their "Staybrite" steel for the work of preservation. A large part of this material was used in the form of reinforcing bars for strengthening the bases of the eight piers which support the dome, for insertion in the cement grouting which was forced under pressure into the loose filling of the piers. After extensive tests with bars of various section, it was found that the oval indented type was the most suitable. Firth "Staybrite" tie rods, threaded at either end, 40ft. long by 4in. diameter, were used for tying up the inner wall of the dome to the outer wall, and were secured by cast washers and nuts of the same material. It is to supplement this reinforcement that the two large chains are needed.

Armour Plate.

Not much armour plate work comes to hand nowadays, and this once valuable department of Sheffield trade has held a very minor place for a long time. There was, however, recently an order from Spain for something under 1000 tons, which provided employment for a time. John Brown and Co. have been able to restart their mill during the past few days, as they have a sufficient number of orders to keep it at work for about six weeks.

Colliery Matters.

Rapid progress is being made with the development of the new Upton Colliery, near Doncaster, work on which was resumed recently after being suspended for a couple of years. The sinking of No. 2 shaft remained to be completed, and this has got on so well that it is hoped to reach coal in a very few days. Work has now been begun on the installation of cages to replace the hoppers which have been used for the sinking. A number of colliers have been signed on to start work immediately the Barnsley seam is tapped. When a heading has been driven to connect the two shafts, a constantly increasing number of men will be set on, and it is hoped that within a year the total employed will reach 2000.

The Closing of Penistone Works.

The decision of the directors of the English Steel Corporation to close the Yorkshire Steel and Iron Works, Penistone, has caused consternation in the little town, so many of whose people have depended on the works for their livelihood. The Penistone Urban District Council has passed a resolution "deploring the sudden necessity which has arisen to close the works, with whose prosperity the welfare of the town has been bound up, and hoping that every effort will be made to lessen and alleviate the distress and suffering which will be occasioned to the workpeople of the company, many of whom have been in their service all their lives." The directors of the Steel Corporation have agreed to receive a deputation from the Council.

Railway Work.

There is no improvement to report in the condition of the departments producing railway tires, springs, and axles. The home railway companies are ordering on a rather larger scale than for some time past, but their requirements are still much below the normal, and, as little work has recently been placed on overseas account, the plants are but poorly employed. The London, Midland and Scottish Railway is to start immediately at its Derby works, on the building of twenty express locomotives of the "Royal Scot" type. The engines will be additional to the fifty of the same design which were built at Glasgow, and which are now in service on the main line to Scotland and elsewhere. The same railway company is also to build a new locomotive depôt at Carlton, between Cudworth and Royston, Yorkshire, as well as 120 houses for the accommodation of the staff.

Cutlery and Plate.

The cutlery and plate trades are quiet at the moment, as the work carried over from last year has been completed and few new orders are coming to hand. As a consequence, a good many operatives are unemployed. A large amount of work is periodically provided by the execution of contracts for the equipment of steamships, and orders of this character are expected shortly, as substantial contracts are now under consideration. The Government Departments which buy cutlery, plate and tools have issued their annual specifications, which are now in the hands of the firms entitled to tender. There was a fall in the value of cutlery exports last year, the drop in December being so large as almost to account for the whole difference. The fall in that month, as compared with December of 1928, was £24,000. The decline covered every section of the industry, and was especially notable in the case of the Australian market, which took only half the quantity of December, 1928. The total value of exports in 1929 showed a fall of £33,000, as compared with 1928, and £29,000 as compared with 1927. Scissors declined by £8500. There was an increase in the exports of safety razors and blades during the first three quarters, but a falling off during the last three months. The grand total value of the exports was £1,146,439. The imports amounted to £730,322, showing a large increase, the figure for 1928 having been £469,025, and that for 1927, £426,841.

A Rolling Mill of Long Ago.

At the Wortley Ironworks, a few miles from Sheffield, there are a number of interesting relics, including the first bar rolling mill operated in England, and a hammer which in all probability forged cannon balls for the use of the Cromwellians. The mill, which is Cort's original undertaking, was used for rolling iron bars from the blooms made under the older shingling, or forge, hammers, which are still in existence. It is only about 5ft. in length by 2ft. in height, and its capacity was probably from 1 to 2 tons of iron bars per day. Mr. J. W. Birdsell, principal of the Wortley Company, who is also connected with James Birdsell and Sons, of Leeds, has undertaken to save this interesting machine for exhibition, but where it will be placed on view has not been decided. A suggestion has been made by Professor Desch, of the University of Sheffield, that the city should have a museum of things which have gone to make its reputation in the steel industry. At the same time, overtures for the acquisition of the mill have been made by the authorities of the Science Museum at South Kensington. There are in the possession of Thomas Andrews and Co., of Royds Works, Sheffield, two cannon balls which are believed to have been made for the battle of Marston Moor. Messrs. Andrews were former owners of the Wortley Works, and the cannon balls were found there in 1868, among a quantity of old black oak beams, when some foundations were being dug out.

NORTH OF ENGLAND.

(From our own Correspondent.)

Coal Prices and Marketing Scheme.

CONSIDERABLE interest is being taken in coal trade circles in the North of England in the efforts which are being made to restore the industry on to more prosperous lines. It would appear from the discussions that are taking place in this area that the half-hour reduction in the daily shift at the mines, although it would increase the cost of production, is much less feared by most men in the coal trade than the marketing schemes, and quotas under Government supervision, as it is believed that these schemes will be very difficult to operate, and will be in no sense advantageous to the export business on which this district so greatly depends. It is considered very probable that an arrangement as to export coal prices in the Baltic will be come to between the Polish coalowners and the Central Collieries' Commercial Association, which controls the Five Counties Marketing Scheme. An agreement on a voluntary basis has been drafted, but the prices of the various grades of coal have yet to be arranged. The counties of Northumberland and Durham, however, have not taken any action regarding the proposal to fix prices at a level below which they shall not fall. The disposition is to wait until the Coal Bill has been disposed of, and then to consider the matter. Whether it is practicable to have a minimum price for the Baltic business is doubtlessly open to question, but not so long ago Poland was selling coal at two or three shillings less than the price she might have got for it. Now she is receiving good prices and wishes to keep them, just as Northumberland and Durham would like to do. Excessive undercutting in the export trade is damaging to all the districts concerned, but the finding of an effective and permanent remedy for this ruinous competition is a big problem.

Cleveland Iron Trade.

The expansion of business in the Cleveland pig iron trade, which was hoped for and anticipated at the beginning of the year, has not yet come about. A fall in the price of raw materials has evidently inspired hopes of cheaper iron, and present needs being largely covered, consumers are inclined to hold off in the hope of a reduction in prices. But makers affirm that there is no margin

of profit, and in spite of the contraction of business adhere to their recent quotations. Current needs nearly absorb the output, but stocks are larger than for some time past. Business with consumers abroad is almost at a standstill, overseas firms refusing to pay ruling rates. A little Midland foundry iron continues to be used in this district, but the imports of foreign products are almost negligible. No. 1 foundry iron is 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; and No. 4 forge, 71s.

Hematite Pig Iron.

East Coast hematite pig iron is rather slow of sale, but producers are fairly well placed as regards orders, and are very reluctant to lower quotations. Merchants, however, have command of a good deal of iron, and do not hesitate to unload their holdings at figures declared by makers to be well below cost of production. Home consumers are taking up moderate quantities, but comparative cheapness of foreign hematite has virtually closed continental markets to makers of East Coast brands. Merchants are selling ordinary qualities of local hematite at 78s. 6d. for early delivery, but producers still quote at least 80s. for supply over periods up to the end of March.

Ironmaking Materials.

Business in the foreign ore trade is confined to transactions in spot lots. Definite quotations for contracts over a period are unobtainable. Blast-furnace coke is now in ample supply, and consumers claim that they can satisfy their requirements at 22s. 6d. per ton for good medium kinds delivered at North-East Coast works.

Manufactured Iron and Steel.

Most of the manufactured iron and steel departments are well employed, but sheet producers are needing work and are cutting prices. Output is heaviest in sections manufacturing shipbuilding, bridge building and railway construction materials. Semi-finished steel is slow of sale, due to the comparative cheapness of foreign products, but firms in this district have still a good deal of work to execute. Prices are firmly maintained.

Shipbuilding Orders.

A further impetus has been given to the shipbuilding industry on the North-East Coast by the placing of orders for three vessels, totalling approximately 30,000 tons, by the Anglo-Persian Oil Company, Ltd., with Palmer's Shipbuilding and Iron Company, Ltd., Hebburn-on-Tyne. The engines for two of these vessels will be built by Doxford and Co., Ltd., Sunderland, while those for the third are to be built by Richardsons, Westgarth and Co., Ltd., Hartlepool, Middlesbrough, and Sunderland.

The Coal Trade.

Although the prompt position for all classes of coal in Northumberland and Durham is very satisfactory, and a good opening for February is assured, there are signs of easier conditions coming. Abroad, as at home, the winter has been very mild so far, and inquiries have fallen off considerably. The collieries, however, have an abundance of orders to go on with, and with large supplies of tonnage at command, the pits have to work at full capacity to keep pace with them. Under the strong prompt market, Northumberland steam coals continue to be indicated at the full late basis, although the forward market is disappointing. Best large steams rule around 17s., and 16s. to 16s. 6d. is the range for other Northumberlands. The section for steam smalls is very strongly supported, and few supplies are on offer at the current values of 11s. to 12s. Gas coals are moving off very readily, and output promises to be fully taken up over the next month. Only occasional January parcels are offered, and for them sellers' prices, or only fractionally less, have to be conceded. Best qualities of Durham gas coal are quoted at 16s. 9d. to 17s., with seconds at 15s. 6d. to 15s. 9d. Bunker coals command 16s. 3d. to 17s. 3d. for leading descriptions, and 15s. 6d. to 15s. 9d. for ordinary kinds. Coking coals make anything from 15s. 9d. to 16s. 3d., according to grade. There is no expansion in the home demand for blast-furnace coke, and patent foundry kinds are slow for prompt export and are quoted at easy late prices. Gas coke is well sold into February, but there are indications that the forward inquiry is less animated. Gas coke is 25s. to 26s., patent foundry 20s. to 21s., beehive 28s. to 30s., and special foundry coke 25s. to 26s.

SCOTLAND.

(From our own Correspondent.)

Quiet Markets.

THE steel and iron markets have shown little signs of life since the holidays. The restart has been a very quiet one and there seems little likelihood of a change for some time yet. Though business is slow, movements are afoot which may eventually prove beneficial to trade in general. One such is the effort being made towards rationalisation and control of sales. Steel makers are organising an Export Steel Association to deal with large export tonnages on special terms, and there may be working agreements arrived at between certain firms whereby the common good may be advanced.

Steel.

On the whole the demand for heavy steel is disappointing. Shipyard orders are slow to materialise, but an improvement may be noted soon in view of recent contracts for new vessels. Steel tubes are particularly quiet at present, no doubt owing to the fact that the International Tube Cartel is having some difficulty in renewing its arrangements. It is expected, however, that the trouble may be removed by the German makers sacrificing part of their business to satisfy the Czecho-Slovakian demands for an increased quota. Meanwhile buyers are singularly quiet. Steel sheets are somewhat uneven. Black sheets have booked a fair amount of business and are comfortably placed at present. Galvanised sheets are a weak spot, however. Demands are light and considerable price-cutting is indulged in. Galvanised corrugated sheets 24 g. are, meanwhile, quoted round about £13 per ton for home delivery.

Iron.

A note of depression is still apparent in the iron trade. Bar iron is almost stagnant and re-rolled steel bars are not much better off. Bar iron prices are unchanged and re-rolled steel bars can be done at about £7 12s. 6d. per ton, home or export.

Pig Iron.

The pig iron market is quiet and is influenced to some extent by the cheap price of Indian pig iron, and offerings of continental iron at lower prices than those ruling for some time. Meanwhile home prices are steady at the agreed minimum level.

Scrap.

The demand for scrap is only moderate. Heavy steel is comparatively easy in price round about 70s. per ton, and cast iron machinery scrap at 69s. 3d. per ton. Heavy basic is a trifle steadier at 65s. per ton.

Coal.

The export coal market continues rather dull. It is thought that continental and Scandinavian countries have comfortable supplies, as shippers here are receiving little encouragement meantime. Fifeshire round fuels are fairly well sold over this month, and though large coals from other districts are readily obtainable, the collieries are not pressing sales with outputs fairly well taken up meantime. On the other hand, in all districts washed materials are weakening. Aggregate shipments amounted to 260,653 tons, compared with 212,363 tons in the preceding week and 221,697 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

SINGULARLY little has happened during the past week in any branch of local industry to create special interest, but more particularly is this the case as regards coal. Anthracite qualities scarcely maintain their all-round firmness, but steam coals are certainly quieter. Yet, at the same time, shipments continue to be good. The Great Western Railway Company's returns of shipments in the foreign and coastwise trade for the week ended the 18th inst. totalled just over 630,000 tons, which compared with 658,000 tons for the preceding week and with rather more than 584,000 tons for the corresponding period of last year. Tonnage supplies have been somewhat irregular, but arrivals over last week-end resulted in there being twenty-one waiting steamers at the various docks, and only three idle tipping appliances. The most noticeable feature about the steam coal trade at the moment is the extremely quiet demand. There appears to be very little buying from any quarter, and there is no doubt that one of the main causes of this is the fact that the weather on the Continent is so unusually mild, while another is that the foreign coaling stations are not doing so much business as less tonnage is on the move. It is also an undoubted fact that the continued fall in outward rates has induced many foreign buyers to hold off; during the past few weeks there appears to have been no bottom to the outward freight market. In only one direction has the market taken an upward move, and that is for South American destinations, the reason being that the homeward grain market has collapsed. The position of shipowners at the moment is by no means an enviable one, as remunerative business is almost impossible to find. Many shipowners have already laid up a number of their steamers. One Cardiff firm owning a modern fleetof seventeen steamers has tied up ten steamers, and each day the number is increased. This action, which is being adopted not only by British owners but foreign shipowners, is bound to have its effect upon the market generally, though it must be said that at the present time there is no indication of any advance in outward rates taking place immediately. This much, however, can be said, and that is that rates can scarcely go any lower, and therefore if foreign coal buyers imagine that they can get any further benefit by waiting to purchase coals, it is extremely improbable that such will be the case, as coal exporters are more likely to increase their ideas regarding c.i.f. prices for the reason that present outward rates of freight are dangerously low to base upon for future business.

Coal, Coke, and Patent Fuel.

Board of Trade returns of the coal, coke, and patent fuel trade of South Wales for last year are interesting, inasmuch as the total compared very favourably with 1928, though the volume was substantially less than for 1913. The aggregate for 1929 of coal, coke, and patent fuel exported abroad as cargo and as bunkers for ships bound for foreign ports was 29,333,568 tons, which was 3,489,863 tons more than for 1928, though 7,073,721 tons less than for 1913. A feature of the trade was the increasing demand for sized coals. In 1928 sized coals exported represented 10·4 per cent. of the total, but this was increased to 13·3 per cent. in 1929, while the average price of these qualities was raised by 5d. per ton to 23s. 6¼d. per ton. The proceeds realised from all Welsh coal shipped abroad as cargo during last year came to £21,989,113, or £3,560,000 more than in 1928. This resulted in an advance in the average f.o.b. price of 7d. per ton to 18s. 1¼d.

Timber and Iron Imports.

Mining timber brought to South Wales ports last year amounted to 69,000 loads more than the total for 1928. The total was 1,314,136 loads, made up of 1,170,144 loads of pitwood and 143,992 loads of pit props. The value of the wood was £1,781,221, or 27s. 1¼d. per load, which was 3½d. more than for 1928, but 2s. 2¾d. less than in 1927. Iron ore imports into South Wales last year came to 1,384,971 tons, as against 1,335,029 tons for 1928 and 998,994 tons for 1927.

Iron and Steel Trade Conditions.

There has been no improvement in the general state of the iron and steel trade of this district. The conditions are generally very quiet and unsatisfactory. The notices which were served upon a number of the workmen of Guest, Keen and Nettlefolds, Ltd., at their Cardiff Dowlais works expired at the end of last week, but, fortunately, they have not as yet taken effect. The men have since then been kept on on day-to-day contracts.

South Wales Electricity Scheme.

Details were last week given in THE ENGINEER of the scheme of the Electricity Commissioners to apply to South Wales and the South-West of England. The proposals were referred to on Saturday last at the dinner of the South Wales branch of the Association of Mining Electrical Engineers held at Cardiff by Major E. Ivor David, of the firm of Messrs. Kane and David, who expressed strong disapproval of them. He stated that colliery power stations had been the pioneers in electricity supply, and in South Wales they had been the first to specialise in high-tension transmission, although others were not long in following. He drew attention to the fact that in a small paragraph in the proposed scheme it was stated that, after the "grid" had been developed, the colliery supply stations might put some of their power into the "grid." He did not think that they would do so. They had stood on their own so far, and they could continue to do so. They were not going to allow the standard of continuity which they had always maintained to suffer, nor would they have the cost of electricity to the mining industry raised at a time when it should be reduced. The prices quoted in the report would certainly not attract any colliery company at the present time.

Engineers and Ship Repairers.

Mr. Robert Smeaton, of Palmer's Dry Dock Company, Ltd., of Swansea, has been elected President of the Bristol Channel Engineers and Ship Repairers Employers' Association, Ltd., in succession to Captain W. Hedley Graham. Mr. L. T. C. Soulsby, general manager of the Cardiff Channel Dry Dock and Pontoon Company, Ltd., has been elected Vice-president.

Current Business.

Best anthracite coals maintain a firm tone, and cobbles and nuts, especially, meet with a ready outlet, but some of the other descriptions are a shade easier to obtain. Steam coals are extremely irregular. Large coals are slow to move off, and it is questionable whether any quality can command more than the minimum prices prevailing. Smalls are firm and scarce, for the reason that work has not been so good at some collieries, owing to the accumulation of large coals. Sized coals are also very steady. There is no change in patent fuel and coke. Pitwood is easy.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE GENERAL ELECTRIC COMPANY, Ltd., asks us to announce that its Bristol branch has been removed from 81, Victoria-street, to "Magnet House," 24, Victoria-street, Bristol. The telephone number is now Bristol 9550 (3 lines).

MR. O. G. BEERE, for many years London representative for Charles Churchill and Co., Ltd., has joined the staff of Leo. C. Steinle, Ltd., 81, Marsham-street, Westminster.

F. G. SMITH (MOTORS), Ltd., asks us to announce that it has opened showrooms at 169, Shaftesbury-avenue, W.C. 2, to handle the Dennis commercial vehicles business in London, under the management of Mr. R. S. Hill. Its existing commercial vehicle depôt at Goodmayes will in future be entirely devoted to the sale and service of Morris-Commercial vehicles under the management of Mr. S. R. Bonallack.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., of Electurn Works, North-road, Holloway, London, N. 7, asks us to announce that it has entered into an agreement with Gibbons Bros., Ltd., of Dibdale Works, Dudley, for the manufacture of large Wild-Barfield industrial electric furnaces. Inquiries regarding box-type heat-treatment, carburising, rotary hearth and continuous and conveyor furnaces may be addressed to either firm.

THE RELAY AUTOMATIC TELEPHONE COMPANY, Ltd., of Relay House, Streatham-hill, London, S.W. 2, and the Sterling Telephone and Electric Company, Ltd., ask us to announce that a fusion of the manufacturing interests of the two undertakings has been arranged. It is requested that in future all inquiries regarding both companies' products should be addressed to Relay House at the above address. Telephone number: Streatham 3200. Telegrams: Relaymatic, Phone, London. Cablegrams: Relaymatic, London.

CONTRACTS.

ROBERT STEPHENSON AND CO., Ltd., Darlington, has received an order from the Central Argentine Railway, Ltd., for twenty tank locomotives, superheated "S.S. 5" class, 0-6-2 type, cylinders 17in. by 24in., gauge 5ft. 6in.

THE INTERNATIONAL ELECTROLYTIC PLANT COMPANY, of Chester, has received an order from the Consolidated Mining and Smelting Company of Canada, Ltd., for a Knowles electrolytic hydrogen plant, to be installed at Trail, British Columbia, to produce hydrogen for synthetic ammonia for artificial fertilisers. The plant is to comprise 306 cells operating at 10,000 ampères, 2·125 volts per cell, connected in series to run as one battery on a 650-volt direct-current supply from mercury arc rectifiers. The hourly production of hydrogen is to be 49,380 cubic feet. Distilled make-up water will be fed to the cells by twelve sets of Knowles automatic water feed and gas washing tanks, and the cells will be equipped with Knowles temperature control.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	19/6 to 22/–
(1) Spanish	23/– to 24/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 1 0	—
No. 1 Foundry	4 0 6	—
No. 3 Foundry	3 18 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 18 6	3 18 6
No. 1	3 19 0	3 19 0
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
MIDLANDS—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 15 6	—
„ „ Foundry	3 19 6	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. COAST— N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 9 6 (*a*), 4 11 6 (*b*), 4 15 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
LANCS.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 2 6 to 9 5 0	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	13 0 0	12 15 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	10 0 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	6 15 0	—
Hoops	9 15 0 to 10 5 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	8 2 6 to 8 15 0	—
Billets and Sheet Bars	6 2 6 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	12 0 0 to 12 15 0	—
Angles	8 7 6	—
Joists	8 10 0	—
Tees	9 7 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/9 to 19/–
Block Tin (Cash)	172 5 0
„ (three months)	175 5 0
Copper (cash)	71 17 6
„ (three months)	68 12 6
Spanish Lead (cash)	21 10 0
„ „ (three months)	21 11 3
Spelter (cash)	19 12 6
„ (three months)	20 5 0
MANCHESTER—	
Copper, Best Selected Ingots	77 17 6
„ Electrolytic	83 15 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	23 2 6
„ Foreign	21 12 6
Spelter	20 0 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	3/4½ per lb.	
Ferro Tungsten	3/1½ per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£22 10 0	6/6
„ „ 8 p.c. to 10 p.c.	£22 0 0	6/–
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£34 0 0	10/–
„ „ „ 1 p.c. carbon	£39 0 0	15/–
„ „ „ 0·70 p.c. carbon	£41 10 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/6 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/10 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/6 to 15/–
„ „ Ell	15/–
„ „ Splint	17/– to 17/6
„ „ Trebles	16/–
„ „ Doubles	14/6 to 15/–
„ „ Singles	14/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	17/6
„ „ Trebles	16/–
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	14/– to 15/6
Screened Navigation	18/– to 19/6
Trebles	17/– to 17/6
Doubles	14/6
Singles	13/6 to 14/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/6
Secondary Steam	14/–
Trebles	17/–
Doubles	14/6 to 14/9
Singles	14/3

ENGLAND.

(8) N.W. COAST—	
Steams	21/6 to 23/–
Household	38/– to 51/–
Coke	26/6
NORTHUMBERLAND—	
Best Steams	17/–
Second Steams	16/–
Steam Smalls	11/– to 11/6
Unscreened	13/– to 13/6
Household	25/– to 37/–
DURHAM—	
Best Gas	16/9 to 17/–
Second	15/6 to 15/9
Household	25/– to 37/–
Foundry Coke	25/– to 30/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	26/6 to 28/–	—
Derbyshire Best Bright House	21/– to 23/–	—
Best House Coal	20/6 to 21/6	—
Screened House Coal	18/6 to 20/–	—
„ „ Nuts	16/6 to 18/–	—
Yorkshire Hards	15/6 to 17/–	—
Derbyshire Hards	15/6 to 17/–	—
Rough Slacks	9/– to 10/–	—
Nutty Slacks	7/6 to 8/6	—
Smalls	3/– to 5/–	—
Blast-furnace Coke (Inland)	17/– on rail at ovens	
Furnace and Foundry Coke (Export), f.o.b.	22/6 to 23/6	

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/– to 20/3
Second Smokeless Large	18/9 to 20/–
Best Dry Large	19/9 to 20/–
Ordinary Dry Large	19/– to 19/6
Best Black Vein Large	18/6 to 18/9
Western Valley Large	18/6 to 18/9
Best Eastern Valley Large	18/3 to 18/6
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	14/3 to 14/9
Ordinary Smalls	13/– to 14/–
Washed Nuts	19/6 to 30/–
No. 3 Rhondda Large	21/– to 21/6
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/3 to 17/6
„ „ Through	15/6 to 16/–
„ „ Smalls	14/6 to 15/–
Foundry Coke (Export)	32/6 to 37/–
Furnace Coke (Export)	29/– to 30/–
Patent Fuel	22/– to 22/6
Pitwood (ex ship)	27/– to 27/3
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	36/– to 38/–
Seconds	30/– to 32/6
Red Vein	26/– to 28/–
Machine-made Cobbles	43/6 to 45/6
Nuts	45/– to 47/6
Beans	26/– to 28/6
Peas	20/– to 20/6
Breaker Duff	10/9 to 11/3
Rubbly Culm	12/6 to 13/–
Steam Coals :	
Large	20/6 to 21/6
Seconds	18/6 to 19/6
Smalls	13/6 to 14/6
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Steel Sales Combine.

THE idea of creating an international sales organisation in the steel trade being now generally accepted, its realisation is making good headway. The opposition to the proposed comptoir is breaking down before the evident necessity of doing something to insure an equitable distribution of orders and a maintenance of prices on a profitable basis. The scheme is being developed, and will be incorporated in the operations of the Steel Cartel, which has failed in its object to obtain automatically more profitable rates by a reduction of output. The basis of operation was that the production should be restricted when stocks reached 50,000 tons, or when London prices fell below a certain level, but as there was no compulsion, beyond the payment of penalties, the conditions were never entirely fulfilled. The sales comptoir is expected to give positive effect to the operations of the Cartel. One of the obstacles to the new organisation was the absence of a national steel union in Belgium, but that has now been accomplished by the constitution of a sales comptoir covering practically all classes of rolled steel. It has been formed for a period of six months, by which time it is expected that the international comptoir will be in operation. Until then, customers will continue to send their orders to the mills and forges, but manufacturers are required periodically to send statements of the orders received and the prices to control offices at Charleroi and Liége. If one maker is found to be receiving more orders than others, he will be required to raise his prices, and in the event of this proving ineffectual to divert orders, he will have to pass on some of the work to other producers who are less favourably placed. By this new arrangement exporters find their occupation gone. Leading exporters will probably act as agents for the comptoir, but the smaller men must, it is to be feared, disappear altogether.

Motor Cars.

The proposal to form a continental association of motor car makers, with the object of resisting the importation of vehicles from the United States, is by no means the illusory scheme it appeared to be when first put forward. Negotiations have been carried through to a point at which the scheme has some chance of meeting with success. It is reported that an understanding has been come to amongst all manufacturing countries on the Continent, and that the first step will be to introduce legislation for the protection of the automobile industry. In Germany it is proposed to limit the importation of cars under the existing duty of 75 reichmarks per 100 kilos. to 25,000 or 30,000 a year, and when that number is reached the duty will be automatically raised to 300 reichmarks. The French Government is already increasing the import duties on automobiles by suppressing the *ad valorem* duties and replacing them by duties on weight, which, it is believed, will represent a substantial advance. The idea of the continental combine originated in Italy, where the motor car industry is suffering severely from the American importations.

Public Transports.

During the past week there was held in Algiers the Annual Congress of railway and public transports, on the occasion of the centenary celebrations of Algeria as a French Colony. It has long ceased to be a Colony, and is a Department of the Mother Country, and its remarkable progress has been due entirely to the engineers who have equipped the country with railways and roads, and have transformed more or less arid territories by an extensive system of hydraulic works. The numerous papers presented dealt almost entirely with questions affecting tramways and motor omnibuses. Amongst the points of interest was the statement of Monsieur Bacqueyrisse, general director of the Paris omnibus and tramway company, that the corrugated wear of tram rails was due largely to the corrosion of impurities in the metal, and that experiments had shown that the trouble could be avoided by the use of a steel with a certain content of silicon. Monsieur Guiffart, director of the Cie Française de Tramways, dealt with substitutes for petrol for motor omnibuses, and remarked that while no progress had been made with benzol and alcohol, and while synthetic fuels were too expensive, the most important factor was the use of heavy oil engines of the fuel injection type, but there were still many difficulties to be overcome before such engines could be employed on public vehicles. Charcoal suction gas and secondary batteries had made little headway. In Paris, some omnibuses had run experimentally on town gas. The results were satisfactory, but the cost of the gas was too high, and the gas engine for motor vehicles would probably receive more attention in the event of cheaper and more abundant supplies coming from the coke ovens at the collieries in the Nord. Several papers were presented upon the competition of the motor lorry with the railway, Monsieur Scheurer stating that the higher cost per ton-mile of road transport was more than made up for by the saving of time and other conveniences. The local railways in Alsace were endeavouring to provide the same conveniences, especially by the adoption of suitable types of containers, but Monsieur Scheurer admitted that a final solution of the problem of road competition was by no means assured. Therefore, other papers showed how the two could work in collaboration. Non-paying local lines can be replaced with motor vehicles; motor cars can be used as feeders for the railways, and motor services can open up districts inadequately served by the railways.

AN innovation introduced when the "Worthing" was put by the Southern Railway on the Newhaven–Dieppe service in the summer of 1928 was the closing in and protection of the promenade deck. That has since been done on some of the Dover–Calais and Folkestone–Boulogne steamers, and now similar provision is to be made on the steamers "Dieppe," "Newhaven," and "Rouen."

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

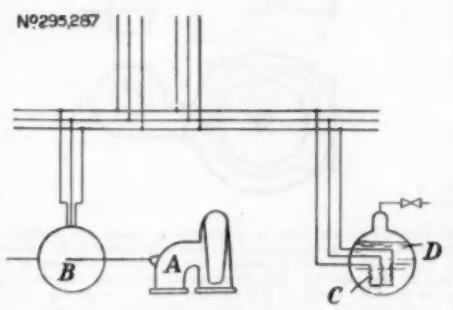
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

295,287. August 8th, 1928.—ELECTRIC POWER STATIONS, *International General Electric Company, Incorporated, of* 120, *Broadway, New York.*

The object of this invention is to provide an economical means of storing up surplus energy generated from time to time in a power station. In the arrangement shown a hydraulic turbine A drives a three-phase generator B supplying bus-bars, from which feeders lead to the consumers. A heating element C within a vessel D constituting a combined vapour generator and heat accummulator is connected to the bus-bars through

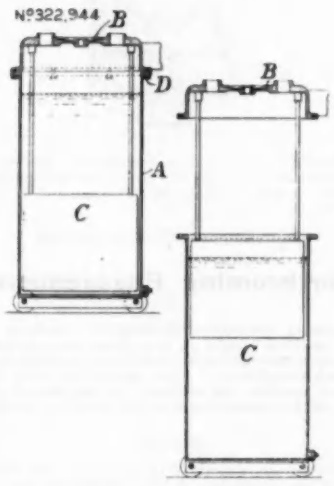


an overload relay, so that, when the generator B is generating more energy than is required by the consumers, the surplus electrical energy generated passes into the heating element D and is converted into steam water which is contained within the vessel. The steam thus generated is stored in the vessel D, from which it may be drawn off for the purpose of driving an auxiliary turbine during periods of peak loads. Where the main generator is driven by means of a steam turbine, the storage steam may be supplied directly to the main steam turbine.—*December 9th*, 1929.

SWITCHGEAR.

322,944. February 2nd, 1929.—ELECTRIC SWITCHGEAR, Switchgear and Cowans, Ltd., and George Henry Neep, both of Elsinore-road, Old Trafford, Manchester.

The object of this invention is to provide an improved and simple means of effecting relative movement between the tank of an oil switch and the mechanism normally enclosed and immersed therein, so as to afford access to the latter for inspection or other purposes. A is the oil tank and B the top plate which carries the circuit breaker and its operating mechanism and is normally seated on the top of the tank and secured in position by studs D. The tank is provided with wheels, or may be mounted in a wheeled truck. From the underside of the top plate a float C is suspended and is normally submerged in the oil in the tank. The buoyancy of the float may be such as to

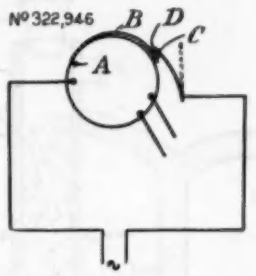


overcome the weight of the top plate and the parts carried by it, so that the application of force will be required to submerge the float, and when the studs D are released the float will lift the top plate and the parts carried by it, as shown in the right-hand drawing. Alternatively, the buoyancy of the float may be such as to balance, or almost balance, the weight of the top plate and the parts carried by it, and thus require the application of but little effort to lower and raise the circuit breaker. The float may be of such size that the oil can pass only slowly from below to above it, and *vice versâ*, and so control its descent and ascent. Alternatively, the float may be a more or less piston fit in the tank, and a by-pass may be provided between the upper and lower parts of the tank, or restricted passages may be provided through the float.—*December 19th*, 1929.

TRANSFORMERS AND CONVERTERS.

322,946. February 4th, 1929.—TRANSFORMERS, *Stanley Gordon Sinclair Dicker, of* 20 *to* 23, *Holborn, London, E.C.* 1.

This invention relates more particularly to transformers utilised for feeding some or all the circuits of a wireless receiving set from alternating current mains. Owing to faults in the receiving set, such transformers are sometimes short-circuited on the secondary side, which gives rise to an undesirable increase of temperature. The invention has for its object to obviate this disadvantage. One of the ends A of the primary winding is bent back over the finished winding and provided with a broad metal lip B on to the end of which a flat spring C is soldered by means of readily fusible metal D. As soon as the output current attains an unallowable value, the heat produced in the

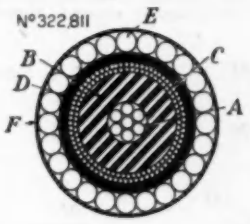


outermost layers of the secondary winding, or in both windings, is absorbed by the lip D and causes the soldered joint D to fuse, so that the member C springs back into the position shown in dotted lines, owing to which the primary circuit is interrupted. As the soldered joint D is provided on the exterior of the transformer, it is easy to re-establish the connection after it has been broken.—*December 19th*, 1929.

TELEGRAPHS AND TELEPHONES.

322,811. September 14th, 1928.—ELECTRIC COMMUNICATION CABLE, Standard Telephones and Cables, Ltd., and Per Engelbert Erikson, both of Columbia House, Aldwych, London, W.C. 2.

This invention relates to cables for electric communication, and more particularly to long submarine telephone and telegraph cables. The invention provides a modified cable, which has an increased efficiency for a broad range of transmission frequencies. The centre core A is a "Litzdraht" type conductor made up of several insulated conducting wires formed into strands and built up into a substantially circular unit.

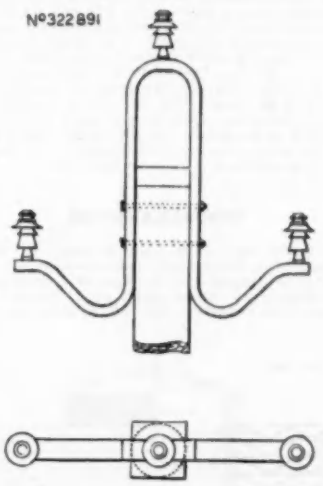


Immediately surrounding the core A is a suitable insulating material B, such as paper, applied in the usual manner. Insulated wires C, arranged in two or more layes, are situated about the insulation B. Enamel may conveniently be used for the insulation of each of the wires C. The customary jute packing D and the armour wires E are then applied. Finally, an outer serving F of tarred jute, yarn, or other suitable material, is provided. In use the core A constitutes one path for the current, the return path being formed by the conducting layer C. When such a cable is used for transmitting high frequencies or carrier frequencies, the losses in the conductors are of a reduced magnitude compared with former type cables.—*December 16th*, 1929.

TRANSMISSION OF POWER.

322,891. December 10th, 1928.—MEANS FOR SUPPORTING OVERHEAD ELECTRIC LINES OR CONDUCTORS, Pirelli-General Cable Works, Ltd., of Southampton, and John Ralph Harding, of "Garth," Northlands-road, Southampton.

The chief object of this invention is to provide a simple and effective pole top of cheap construction which will enable the



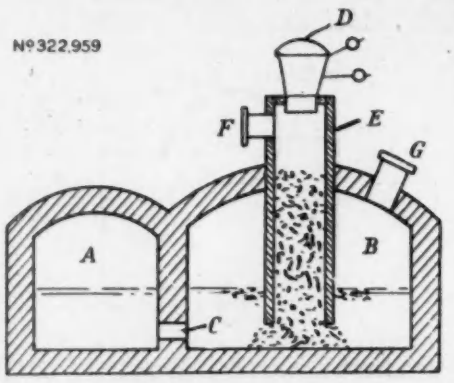
use of a supporting pole of a less height than hitherto with a consequent decrease in the cost. The pole top consists of a single length of metal bent into the form of a parallel-sided loop, the end portions of the side members of which are bent to form sloping laterally extending arms with short horizontal ends, the top of the loop and the ends of the arms receiving upright or pin-type insulators.—*December 19th*, 1929.

GAS PRODUCERS.

322,959. February 20th, 1929.—A PROCESS FOR THE EXTRACTION OF GASES FROM AND FOR THE GASIFICATION OF FUELS, Lichtenberger, Hohenstaufenstrasse 15, Stuttgart, Germany, L. Kaiser, Schlossstrasse, 4 Herbe-Ruhr, Germany, and F. Meyer, Wasserturmstrasse 1, Dresden, Germany.

The inventors propose to gasify coal by immersing it in a bath

of fused salt. The salt is first fused in the chamber A and is then admitted to the main chamber B, by the openings C. The coal is supplied from a sealed hopper D, and falls down the shaft

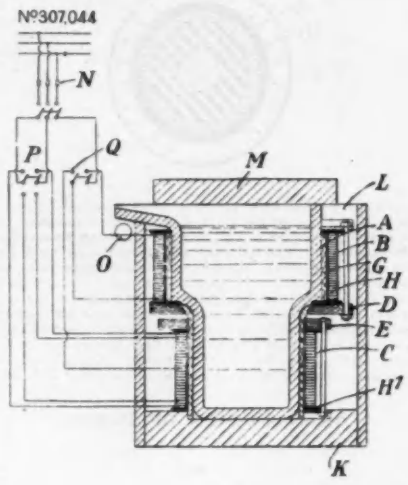


E into the bath of molten salt. The volatile contents of the coal are distilled off and delivered at F. The resulting coke floats up through the salt and is exposed to superheated steam, to form water gas, which is drawn off at G.—*December 19th*, 1929.

FURNACES.

307,044. September 6th, 1928.—IRONLESS INDUCTION FURNACES, Hirsch, Kupfer- und Messingwerke Aktiengesellschaft, of Messingwerk, near Eberswalde, Germany.

This specification describes an ironless induction furnace in which the inductor windings are divided into two separate coils and energised from different phases of a polyphase circuit of low frequency and surrounding the upper and lower portions of the furnace. A represents a crucible surrounded by two coils B and C of copper strip or copper tube. The two coils are connected together in a Scott's circuit system. Between the two coils B and C are the two rings D and E, which are made of transformer sheet iron and are preferably separated from one another by distance pieces of non-magnetic material. Between the crucible

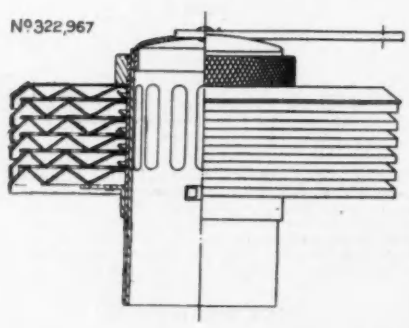


A and the coils B and C there are a heat-insulating layer G and a cylinder H of electric insulating material. The same electric insulating material can also be used to separate the coil windings. The intermediate layers between the coils and the iron rings or between the coils and the coil clamping devices can also be made of the same material shown at H^1. The furnace is covered by a cover M of refractory material, such as fire-brick. The base K can be made of the same material. The cover rests on annular segments L. The furnace is tipped about an axle O which is below the pouring spout. The two coils are connected to the polyphase current leads by a three-pole switch N. The lower coil can be wholly or partially connected by the switch P in order to adjust the power supplied to the furnace. The upper coil is inserted by the switch Q.—*December 6th*, 1929.

MISCELLANEOUS

322,967. March 6th, 1929.—AIR FILTERS, H. Wittemeier, Bismark-Allee, Berlin-Grunewald, Germany.

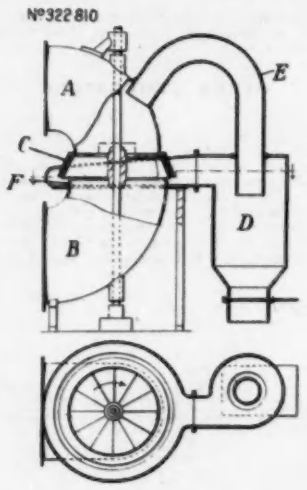
This filter is composed of a series of corrugated annular plates assembled on a central suction pipe. Between the corrugated plates there are other—flat—plates which are perforated.



The flow of air is from the openings at the edges of the plates, up and down through the perforations, and inwards to the suction pipe. It is claimed that the turbulence thus produced deposits any dust in the air in the pockets of the corrugations, but its ultimate removal is not explained. Special claim is made for the proportioning of the perforations and pockets in such a manner that the velocity of the air is first rapidly increased and is then allowed to subside towards the suction pipe.—*December 19th*, 1929.

322,810. September 14th, 1928.—CENTRIFUGAL DUST SEPARATORS, B. Pochobradsky, Goodwood, Lansdown-road Sidcup, Kent.

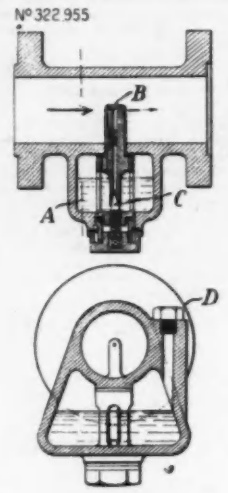
This apparatus is for the extraction of dust from, say, flue gases. The gas inlet is shown at A and the outlet at B. On its way the gas passes through the conical fan-like member C, with



the result that the dust is concentrated round the periphery. The dust, with a proportion of the gas, is led away to the cyclone D, where the dust is deposited, and the gas is returned to the inlet by the pipe E. The clean gas is led away by the main outlet pipe B, which, it will be seen, has a projecting edge at F to prevent its contamination by the dust.—*December 16th*, 1929.

322,955. February 15th, 1929.—AUTOMATIC LUBRICATORS FOR AIR PIPE LINES, Pechelbronn Société Anonyme d'Exploitations Minières, Merkivellier, Pechelbronn (Bas-Rhin), France, and A. L. Becker.

In this lubricator oil is sucked up from a reservoir A by a



Pitot tube-like device B, and is thus delivered into the current of compressed air. The rate of delivery can be regulated by the needle valve C, while a filling cap is provided at D.—*December 19th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TO-DAY.

INSTITUTION OF CHEMICAL ENGINEERS.—In the Lecture Theatre of the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. 1. "Films and Fibres Derived from Cellulose," by Dr. Herbert Levinstein. 6.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Anderson Rotary Piston Engine," by Mr. John H. Clarke. 5 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON): MANCHESTER CENTRE.—In the Building of the Manchester Literary and Philosophical Society, 36, George-street, Manchester. Presidential address by Mr. J. R. Bazin. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, London, S.W. 1. "General Operating Experiences with the First 'Wood' Steam Generator," by Mr. E. Watson Smyth. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Refractories for Steam-raising Furnaces," by Mr. W. J. Rees. 7.30 p.m.

LONDON COUNTY COUNCIL SCHOOL OF ENGINEERING AND NAVIGATION.—High-street, Poplar, E. 14. Prize distribution by Miss Isbbel MacDonald and open night. 7 to 10 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. "Failure of Steel Forgings and Castings through Fatigue," by Mr. Robert A. MacGregor. 6 p.m.

PHYSICAL SOCIETY.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. Meeting, 5 p.m. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, London, W. 1. Discourse, "Cellulose in the Light of X-rays," by Sir Wm. Bragg, F.R.S. 9 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—In the "Societies' Room," No. 24, Royal Technical College, George-street, Glasgow. The Council will meet at 7 p.m. in Committee Room No. 26. "Continental Blast-furnace Practice," by Monsieur F. Clerf. As Monsieur Clerf is unable to be present, his paper will be read by Mr. E. H. Rogerson. Cinema film will be shown, "From Ore to Finished Product" (third reel). 7.30 p.m.

SATURDAY, JANUARY 25TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, JUNIOR SECTION.—In the College of Technology, Sackville-street, Manchester. "Foundry Costing," by Mr. J. O. Gray. 7 p.m.

MONDAY, JANUARY 27TH.

INSTITUTION OF ELECTRICAL ENGINEERS: NORTH-EASTERN CENTRE.—At Armstrong College, Newcastle-upon-Tyne. "The Breaking Performance of High-power Switchgear and of a New Form of Quenched-arc Switch," by Mr. L. C. Grant. 7 p.m.

KEIGHLEY TEXTILE SOCIETY.—An inter-lecture with the Keighley Association of Engineers, in the Kiosk Café, North-street, Keighley. "Modern Improvements in Worsted Machinery," by Mr. A. Bennett. 7.30 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—St. John-street, E.C. 1. "Realism from Records," by Mr. G. A. V. Sowter. There will also be a demonstration with apparatus lent by Dr. N. W. McLachlan. 5.30 p.m.

TUESDAY, JANUARY 28TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Graduates' visit to the works of Morris Motors, Ltd. (Engines Branch), Gosford-street, Coventry. 8 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, W.C. 2. London Graduates' informal meeting. "Discussion, "Tuning Motor Cycles for Speed," by Mr. S. C. Vince. 7.25 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Paper to be submitted for discussion, "Stable Channels in Alluvium," by Mr. Gerald Lacey. 6 p.m.

SHEFFIELD METALLURGICAL ASSOCIATION.—198, West-street, Sheffield. "Density of Molten Steel," by Mr. B. S. Smith. 7.30 p.m.

WEDNESDAY, JANUARY 29TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Works of the Austin Motor Company, Ltd., Northfield. Graduates' meeting. "The Value of the Institution to its Junior Members," by Professor W. Morgan. A discussion will follow. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS, INSTITUTION OF ELECTRICAL ENGINEERS, INSTITUTION OF MECHANICAL ENGINEERS: MIDLANDS AREA.—Annual joint meeting in the Large Lecture Theatre, Birmingham and Midland Institute, Paradise-street, Birmingham. Faraday Lecture, "Broadcasting by Electric Waves," by Capt. P. P. Eckersley. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Students' meeting. "Highways, and a Survey of Future Developments," by Mr. Archibald Harry Kennard. 6.30 p.m.

THURSDAY, JANUARY 30TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—The Vernon-Harcourt Lecture will be delivered at the Chamber of Commerce, New-street, Birmingham, "The Deterioration of Structures in Sea Water," by Professor S. M. Dixon. 6 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Denison House, 296, Vauxhall Bridge-road, Westminster, London, S.W. 1. "The Development of the Geared Steam Locomotive," by Mr. T. Grime. 6 p.m.

INSTITUTION OF WELDING ENGINEERS.—In the Large Assembly Room, Chamber of Commerce, 95, New-street, Birmingham. "Modern Improvements in Electric Resistance Welding Machines," by Mr. C. A. Hadley. The paper will be illustrated by lantern slides and will be followed by a discussion. 7 p.m.

LEEDS ASSOCIATION OF ENGINEERS.—At the Griffin Hotel, Leeds. Lecture on "Sheet Metal Working Machinery," by Mr. H. Ridgway. 8 p.m.

FRIDAY, JANUARY 31ST.

DIESEL ENGINE USERS ASSOCIATION.—In Caxton Hall, Caxton-street, Westminster, London, S.W. 1. "High-powered Oil Engines for Land Purposes," by Mr. W. S. Burn. 3.30 p.m.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (associated with the Faraday Society.)—Northampton Polytechnic Institute, St. John-street, London, E.C. 1. Convention and Exhibition. An exhibition representative of modern scientific and practical advances in electro-deposition will be on view at the Institute during the day. "Research and Practice," by Dr. W. Rosenhain, F.R.S., 4 p.m. A discussion will take place on "The Present Position of Chromium Plating," 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. Paper, "Superheating," by Mr. F. Onions, illustrated by film. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Bolbec Hall, Newcastle-upon-Tyne. Graduate Section. Joint meeting. "The Electrical Propulsion of Ships," by Mr. W. G. Thompson. 7.15 p.m.

SATURDAY, FEBRUARY 1ST.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Annual dinner at the Dudley Arms Hotel, Dudley. 6 p.m.

WEDNESDAY, FEBRUARY 5TH.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Annual dinner, Midland Hotel, Manchester. 6.30 for 7 p.m.

FRIDAY, FEBRUARY 14TH.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, Westminster, London, S.W. 1. Informal meeting. Lantern lecture, by Mr. G. Stevenson Taylor, followed by a visit to the Home Office Industrial Museum. 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Annual dinner, Midland Hotel. 6.45 for 7.15 p.m.

MONDAY TO FRIDAY, FEBRUARY 17TH TO 28TH.

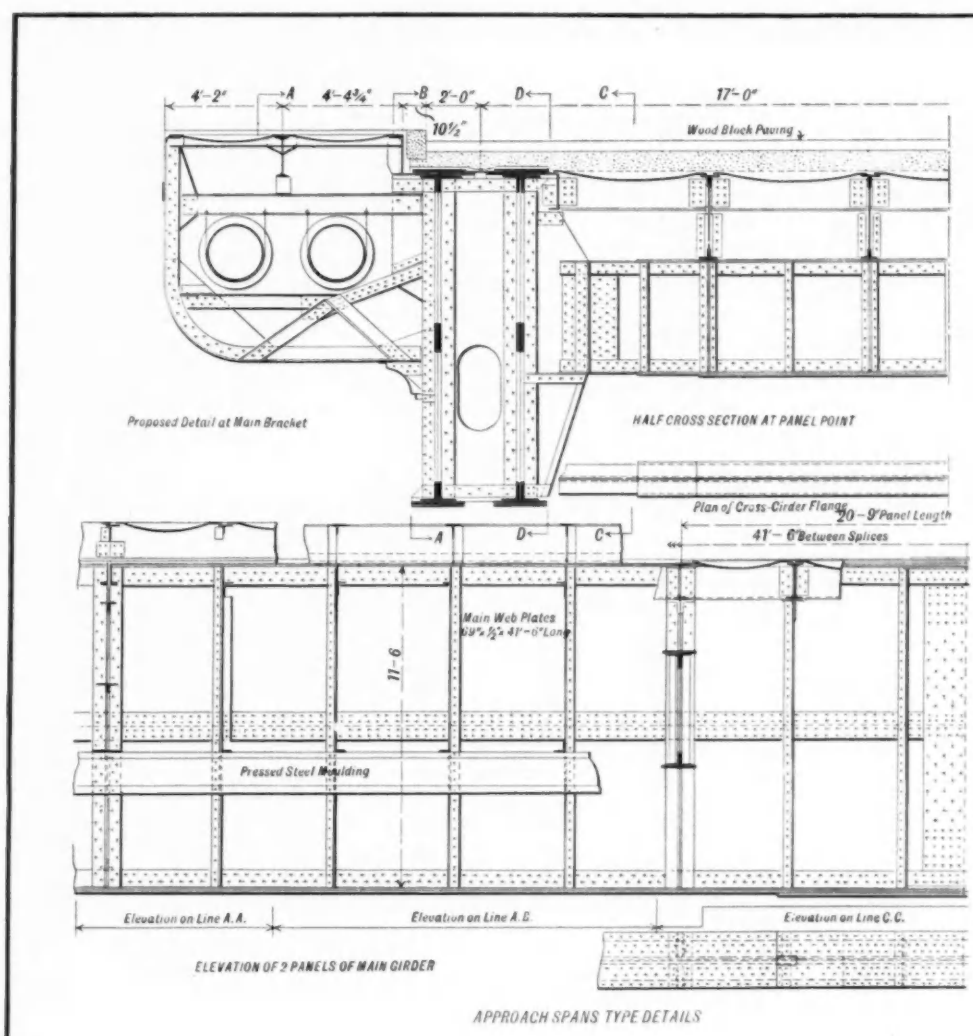
BRITISH INDUSTRIES FAIR.—Olympia and Castle Bromwich, Birmingham.

SATURDAY, MARCH 29TH.

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.—Trocadero Restaurant, London. Annual dinner.

NEWCASTLE-GATESHEAD NEW ROAD BR

BUILT BY DORMAN, LONG AND CO., LTD., TO THE DESIGNS OF MESSRS. MOTT, HAY

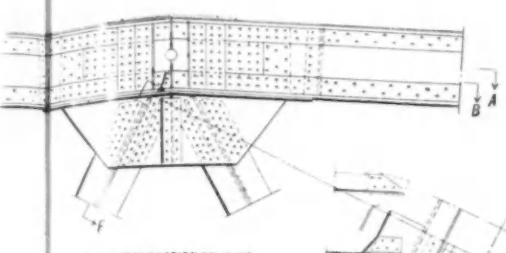


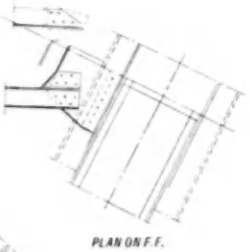
"THE ENGINEER"

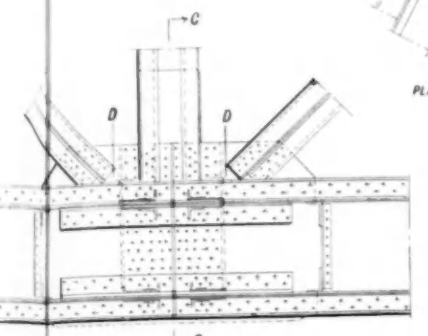
UNIV OF MICH

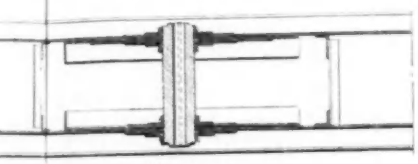
AL BRIDGE—DETAILS OF STEEL WORK

OTT, BAY AND ANDERSON AND MESSRS. COODE, FITZMAURICE, WILSON AND MITCHELL

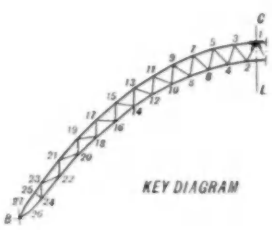


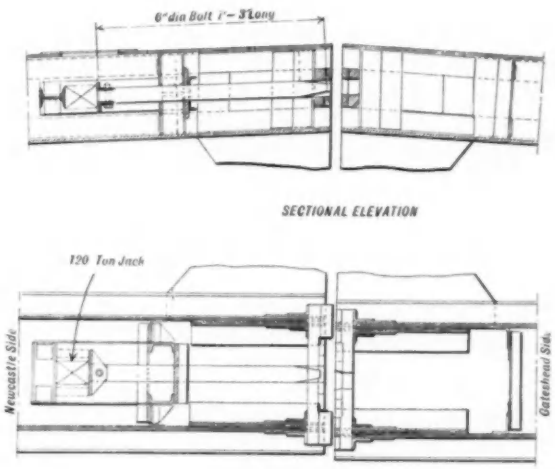






MAIN SPAN TOP CHORD
DETAIL AT CENTRE PANEL POINT.

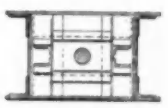


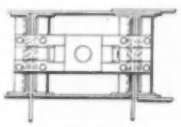


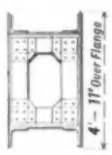
SECTIONAL ELEVATION

SECTIONAL PLAN

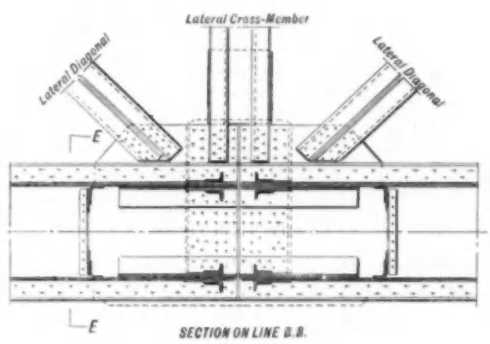
ALIGNMENT BOLT IN TOP CHORD OF MAIN SPAN



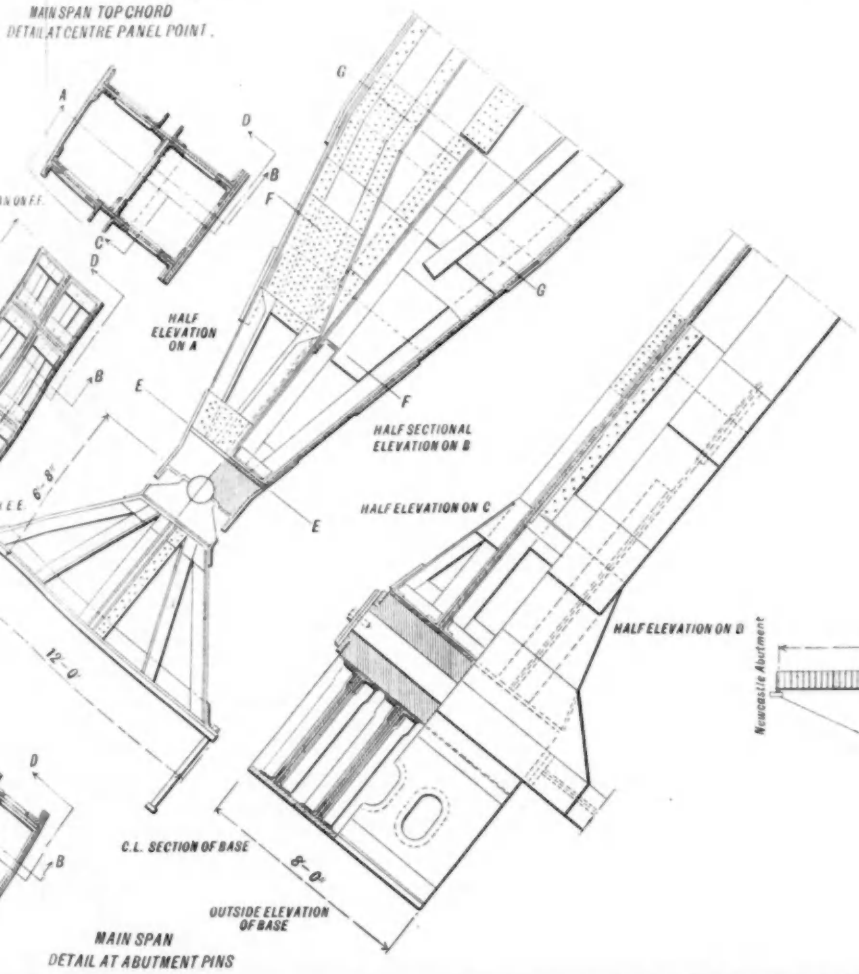




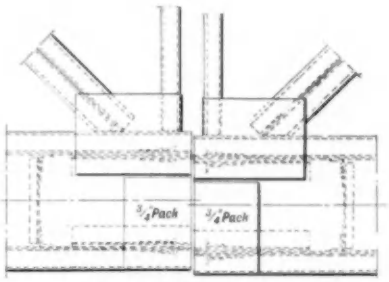
SECTION ON E.E



SECTION ON LINE B.B.

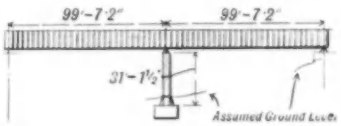


MAIN SPAN
DETAIL AT ABUTMENT PINS

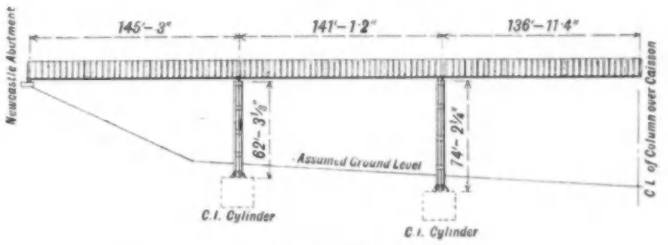


PLAN ON TOP WITH FLANGE COVERS OFF
(During Erection Before Alignment of Trusses)

MAIN SPAN TOP CHORD
DETAIL OF WIND BRACING CONNECTIONS



GATESHEAD APPROACH SPANS



NEWCASTLE APPROACH SPANS

LONGITUDINAL SECTION
- Shewing -
Inside Elevation of East Girder

UNIV. OF MICH.